TRANSACTIONS

OF THE

HIGHLAND AND AGRICULTURAL SOCIETY

OF

SCOTLAND.

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SOCIETY OF SCOTLAND.

JULY 1845—MARCH 1847.

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CONTENTS.

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PRELIMINARY NOTICE.

Since the publication of the last Preliminary Notice in the first number of the new series of the Journal of Agriculture for July 1843, the Directors have endeavoured to carry out the views then determined on for the continued utility and prosperity of the Society; and they are happy to find that these have been attended with success. The number of members who have since joined the Society has been greater than during any former period of the same extent, the entrants having been 263; and it is gratifying to find that the alphabetical list contained in the last number of the Transactions is more numerous than any former one it has ever published. In thus noticing the prosperity of the Society, the Directors feel gratification in acknowledging the cordial support they have received from all branches of the community in maintaining it in the distinguished position it has long held among the useful institutions of the country.

In adverting to the many important matters which have engaged the attention of the Society since the publication of the last preliminary notice, the Directors will only refer to a few of the greatest interest to the country.

Dundee Show.—The Annual General Show of live stock, dairy produce, implements, wool, &c. for 1843, was held at Dundee on the 8th, 9th, and 10th of August; and though the entries in the aggregate were not so numerous as in the preceding year at Edinburgh, they were such as to reflect high credit on the public spirit of the district. The attendance of noblemen, gentlemen, and practical agriculturists generally, was very numerous.

The stock from Aberdeenshire, Angus, Forfar, and Fife-

shire was very extensive; and these met not only with stock from Galloway and the Borders, but even from the north-eastern and midland counties of England. The facility, indeed, with which valuable live stock can now be transported was most forcibly evinced at this General Show; and it is to be hoped that breeders situated at a great distance from the locality of any of these shows will feel convinced that, with the daily increasing facilities of communication, little danger or injury can befall their animals from their transportation.

Glasgow Show.—The Annual General Show for 1844 took place at Glasgow, on the 7th, 8th, and 9th of August. In alluding to this show, the Directors congratulate themselves on the augmented interest it excited, and especially on the great increase of valuable stock and implements, &c., of all descriptions, which were brought forward for competition. In point of numbers, they much exceeded those exhibited on any former occasion. At the General Show in Edinburgh in 1842, the number of stock exposed in competition was 1014, whilst at Glasgow they exceeded 1400. These were sent from almost every district in the kingdom —from the extreme north of Sutherlandshire to the southern counties of England. The improvement in quality in the stock, &c. shewn, was not less conspicuous than their increase in number.

Public Breakfast, 1844.—At the Glasgow General Show a new feature was introduced, which the Directors are happy to find was attended with much interest to the numerous practical agriculturists then assembled, viz. the scientific *conversazione* at the public breakfast, on Saturday, August 10.

The full attendance of agriculturists of all classes attested the growing desire to combine the principles of science with practice, and to communicate mutual instruction, by the diffusion of that species of knowledge which can alone be acquired by experience and observation.

The subject of lecture was "The best means of making the practical farmer acquainted with the recent discoveries in science, and enabling him to apply them to the cultivation of his own farm." An interesting discussion then ensued on the "failure in the potato crop," in which Sir R. Bateson and Mr Anderson from Ireland, Mr Colquhoun, M.P., Mr Alexander of Southbar, Mr Burnett of Gadgirth, Mr Stirling of Kenmure, Mr Fleming of Barrochan, and Professor Johnston, took the most prominent part. Reunions of this kind of men of science and of practical experience, from different parts of the kingdom, cannot but prove objects of the first interest to agriculturists generally.

Agricultural Chemistry.—It was reported, at the half-yearly meeting of the Society, in July 1843, that the appointment of a

Chemist had been made by the Agricultural Chemistry Association—an important step to aid the practical farmer in under standing the principles which should direct him in the prosecution of his daily avocations. The Directors have much pleasure in observing the interest excited amongst all classes by this appointment. In illustration of the labours of Professor Johnston, it is only necessary to refer to what was accomplished in the first year of his appointment. Not only had 242 analyses of soils, guano, waters, ashes of plants, marls, &c. been effected, but public lectures had been repeatedly delivered in some of the more important districts of the country.

The subjects of these lectures embraced the general theory of manures, food of plants, use of manures, mode of applying them, methods of improving the soil, the benefits of draining, the use of lime, the qualities and use of guano, and the feeding of stock.

The Directors feel that the country generally are indebted to the Agricultural Chemistry Association for the step thus taken, and the good which that body has already effected may be taken as an evidence of that which is yet to be derived from its exertions.

Anniversary General Meeting, 1845.—At the Anniversary General Meeting of the Society in January last a change took place in the office-bearers. His Grace the Duke of Richmond, having been elected in 1841, had then completed the fourth year of the term beyond which, by the provisions of the charter, the President could not hold office.

The Directors proposed to the Meeting that his Grace the Duke of Montrose, who had been Vice-president during the years 1838-39, and who had most satisfactorily discharged the duties of that office, should be elected President during the ensuing year; and the proposal was carried unanimously.

It is only due to the Duke of Richmond to say, what the Members as well as the Directors are well aware of, that while at the head of the Society his Grace had discharged the duties of the chair with the utmost zeal and efficiency. He was in his place at every great Annual Meeting that had been held during his term of office, in whatever locality it took place; and to the other business of the Society, as well as to the correspondence devolving on the chair, he had given the most prompt and careful attention. The Directors therefore feel that there can be but one opinion as to the debt of gratitude the Society owe to their late noble President.

The Society had then to regret the loss of an estimable office-bearer—one of the most zealous they ever had—the late Sir Neil Menzies, Bart., the Honorary Secretary, whose lamented death occurred soon after the Annual Country Meeting of 1844.

The Society, however, have been fortunate enough to secure the services of Mr Hope Johnstone of Annandale as a successor to this office, a gentleman eminently qualified to fulfil its duties, by his business habits and great practical experience.

Electro-Culture.—Among the varied subjects of scientific importance which have lately engaged their attention, the Directors would notice that of Electro-culture.

By the liberality of James A. Gordon, Esq. of Knockespock, the sum of thirty sovereigns has been placed at their disposal as a premium for the best essay upon the application of galvanism or electricity to the cultivation of plants.

The application of this subtle and powerful agent to such a purpose has recently been made public by the experiments of R. D. Forster, Esq., M.D., of Findrassie House, near Elgin; and without being too sanguine in their expectations as to the benefit to be obtained by the agriculturist from such a course of experiment, the Directors hope that the attention of practical farmers being thus directed to the subject, whatever advantages may be derived from it will be ascertained and published for the general good.

Tussac Grass.—In the Transactions for July 1844, the Directors published an official letter from Lieutenant R. C. Moody, Governor of the Falkland Islands, to Lord Stanley, the Secretary for the Colonies, regarding the introduction of this grass into the Highlands and Islands of Scotland. The Society has since received the following letter on the arrival of the seed in this country:—

"Downing Street, *5th September* 1844.

"Sir,—I am directed by Lord Stanley to forward you the accompanying parcel of Tussac Seed, which has been presented to his Lordship by the Governor of the Falkland Islands, and which he desires to present to the Highland Society.—I am, Sir, your very obedient servant, G. W. Hope.

"Sir C. Gordon,
"Highland and Agricultural Society,
"Edinburgh."

The Directors, having obtained the seed, allotted parcels of it to members of the Society located in situations and soils best adapted to its successful cultivation; and should it have been transmitted to this country in the state fitted for successful germination, and sown with the care so interesting an experiment demands, they will have pleasure in receiving and publishing the results.*

Trigonometrical Survey of Scotland.—The suspension, some years ago, of the trigonometrical survey of Scotland, was, to the

* It may be mentioned that gentlemen desirous of experimenting on the cultivation of this apparently valuable grass may obtain its seed, by purchase, from Mr Baillie, general colonial agent, No. 5, Cannon Row, Westminster, London.

Directors, a matter of much disappointment. A memorial was transmitted, through the Duke of Richmond, the President, to the Lords Commissioners of her Majesty's Treasury, urging the recommencement of this national undertaking. As the result of their application the following favourable reply was received:—

"TREASURY CHAMBERS, *Dec.* 5, 1843.

"MY LORD DUKE,—The Lords Commissioners of her Majesty's Treasury, having had under consideration a memorial from the Highland and Agricultural Society of Scotland, dated July 4th last, praying that the ordnance survey of Scotland may be carried on with greater expedition, I have it in command to acquaint your Grace, for the information of the said society, that the second triangulation for the survey in question is in progress in the county of Wigton; and instructions have already been given to take the proper measures for ascertaining the legal boundaries, preparatory to the introduction of such a force of surveyors as the sum which it will be practicable to allot, in future years, for the operations of the survey in Scotland, out of the amount voted by Parliament, for completing the ordnance surveys in Great Britain and Ireland, may allow of.—I have the honour to be, my Lord Duke, your Grace's obedient Servant, C. E. TREVELYAN.

"To his Grace the DUKE of RICHMOND, K.G. &c.,
"President, &c. &c. &c."

The Directors, having fully considered this communication from the Treasury, came to the resolution that the surveys they had formerly instituted, for the elucidation of the geological structure and physical condition of the soils in the different districts of the country, should cease, and the premiums offered on these subjects should be suspended. They will continue, however, to publish in their Transactions such geological surveys as have already been received by them and have not, as yet, been made public.

Communication from the Imperial Agricultural Society of Vienna.—The Directors always have great pleasure in specially noticing those countries which seem desirous of becoming acquainted with our agriculture, and are thus happy to submit in translation the following letter which they have received from Austria:—

"VIENNA, 18*th May* 1844.

"HONOURABLE COMPANY,

"The Imperial Agricultural Society of this place (Vienna) has, for a long time past, had opportunities of appreciating in a high degree the extensive activity developed by the honourable Agricultural Society of Scotland, and have been induced, in consequence, to express a desire that a more intimate connexion of mutual communications, by a reciprocal exchange of transactions and publications, might be established between both societies, thereby advancing still more successfully the fair object of their joint labours.

"As president of the society at this place, I convey to you the expression of this their desire, and at the same time have the pleasure of transmitting to you volumes i.-xii. of their former Transactions, and the first part of the first volume of the second series; and have to state also that it will afford to our society the greatest pleasure to continue to forward to you the future publications in like manner; at the same time they express a desire that the honourable Agricultural Society of Scotland will have the goodness to forward to us their estimable publications, by which means the fruit of labours in the same field, carried on by both societies, in two countries widely separate, will become their common good. COLLEREDO MANSFELDT."

To this communication the Directors returned the subjoined answer:—

"The Highland and Agricultural Society of Scotland have received Count Colleredo Mansfeldt's letter, conveying the wishes of the Imperial Agricultural Society of Vienna to have an interchange of Transactions and publications between the two societies. The Highland and Agricultural Society have great pleasure in acceding to this, and they beg to request that the president of the Vienna society will convey to its members the thanks which have been unanimously voted by the directors of the Highland and Agricultural Society, for the valuable present made to their library of the published volumes of the Imperial Society's Transactions. They beg, in return, to place at the disposal of the Imperial Society a copy of the second and new series of the Highland and Agricultural Society's Transactions, and shall have much satisfaction in transmitting, from time to time, the continuation of this work, as it periodically appears. The Highland and Agricultural Society have to regret that the first series of their Transactions has been long out of print, and that they have it not in their power to offer to the Imperial Society a copy of their earlier productions.

"HIGHLAND & AGRICULTURAL SOCIETY'S HALL,
"*December* 1844."

The Cattle Epidemic.—This fatal disease, originating in the marshy swamps of Hungary, extending northward, and destroying in its progress great numbers of cattle, made its appearance in this country in the beginning of this year. The subject was brought before the Society at the General Meeting in January by Professor Low. To prevent its diffusion in this country, by cattle brought here for sale, the Directors addressed a letter to the Board of Trade, requesting further information, and begging that, if requisite, an efficient *cordon* might be established at the ports at which stock are imported. The Society was favoured with the following reply:—

"OFFICE OF COMMITTEE OF PRIVY COUNCIL FOR TRADE,
"WHITEHALL, *19th February* 1845.

"SIR,—With reference to your letter of the 14th instant, on the subject of the epidemic disease now raging amongst cattle, I am directed by the Lords of the Committee of Privy Council for Trade to acquaint you, for the information of the Highland and Agricultural Society of Scotland, that, in consequence of the attention of the Lords of her Majesty's Treasury having been called to this subject, by the Lords of this Committee, their Lordships have instructed the Commissioners of Customs to direct their officers carefully to examine any cattle imported into this country; and in the event of their appearing to be infected with any disorder, not to permit them to be landed without inspection, as to their soundness, by some competent person, and to report forthwith the circumstances to the government.—I am, Sir, your most obedient servant, J. MACGREGOR.

"Sir C. GORDON, Secretary, &c."

Shortly afterwards the following letters were also received:—

"WHITEHALL, *15th March* 1845.

"SIR,—With reference to my letter to you of the 19th ult., on the subject of the epidemic disease now raging among cattle on the Continent, I am directed by the Lords of the Committee of Privy Council for Trade to transmit to you, for the information of the Highland and Agricultural Society of Scotland, the accompanying copy of a letter from her Majesty's Minister at Brussels, which my Lords have

received from the Foreign office, stating that the reports which had been circulated of the "German Epizootic" having spread into Belgium are entirely without foundation.—I am, Sir, your most obedient servant, J. MACGREGOR.
"To Sir C. GORDON."

Copy Letter from Her Majesty's Minister at Brussels.

"BRUSSELS, 11*th March* 1845.

"MY LORD,—Reports having obtained circulation respecting the appearance here of some cases of the "Epizootic" which has been raging in Germany, I thought it right to wait yesterday upon the Minister of the Interior, and beg him to acquaint me exactly what degree of confidence was to be attached to these rumours.

"M. Nothomb assured me, in the most positive manner, that the disease of which some traces had been observed in Belgium, particularly in the district of Herve, was simply that of which some cases occur annually at this season, and added, that he had every reason for believing that no one case of the real "Epizootic" had yet occurred on this side of the Rhine. These assurances, he said, he was quite ready to give in an official letter, if such should be my wish. An arrête, prescribing the sanitory precautions to be adopted, in the event of a nearer approach of the "German Epizootic," is now in preparation, and will appear in the course of a few days.

"No time shall be lost in bringing these regulations to the knowledge of her Majesty's government.—I have the honour to be, &c., J. H. SEYMOUR.
"To the EARL of ABERDEEN, &c., &c."

Notwithstanding all these precautions the disease has manifested itself in several parts of Scotland; and though the cases in which it has appeared indicate more a *sporadic* than an *epidemic* tendency, it nevertheless calls for the most energetic means being used by owners of stock to guard against its appearance near them. As the disease is of a severe nature, and rapidly fatal in its consequences, the farmer cannot be too strongly cautioned to take every proper step for the efficient treatment of the disease, and the careful isolation of his healthy stock whenever it occurs in his premises.

The disease also being of an insidious nature, and highly complicated in the symptoms which it presents, often runs its rapid course before the farmer is even aware of its existence; and it should therefore be impressed upon the owners of stock that their only safety consists in obtaining, as promptly as possible, the professional assistance of a properly licensed practitioner.

The Museum.—The interest taken by the public in the Agricultural Museum is satisfactory. Since the free admission of the public, the average attendance of visitors has been from 350 to 400 monthly; and the donations of models, roots, seeds, &c., received from time to time, render it one of the most attractive institutions in the city.

Monthly Meetings.—The Monthly Meetings of the Society, held in the Museum during the winter and spring months, have been attended by a greater number of farmers in this than in former years. Their success, though slow, is progressive; and, from the interest displayed in bringing forward objects of practical importance, their increase in usefulness may be confidently pre-

dicted. The proceedings of these Meetings are carefully reported and widely circulated. The Directors hope that practical farmers in the surrounding districts will still continue to favour the Meetings with their presence, and take part in the discussions; and that those at a distance will forward to them the results of their experience.

New Dies for Medals.—A descriptive note of the two new Medals which the Society have recently introduced into their premiums, will be found in the Transactions for July 1844, as also accompanying plates representing fac-similes of all the medals.

Edinburgh Veterinary College.—The attendance of practical pupils on the Veterinary College is now greater than in former years. No fewer than thirty-seven candidates have obtained diplomas since the publication of the last notice. From the increasing interest which this institution is exciting throughout the country by the benefits it confers, it has been found necessary to extend the curriculum of study to be followed by the students. The branches now taught are not confined merely to the structure and diseases of the horse, but those of all other domestic animals are also included, with the important collateral subjects of chemistry and *Materia Medica*. From the growing attention paid to the breeding of neat cattle and sheep, in every part of the kingdom, the Directors have further had under their consideration to add to the above departments a course of instruction in the principles of breeding the different varieties of the domestic animals at present reared in this country. From what has been stated, it will be seen that such a course will prove of the highest importance to all having the care or charge of such animals.

By the issuing of a Charter of Incorporation for the Veterinary profession, the control of the Society over the Veterinary College in Edinburgh has been superseded. The Directors, however, have not, in consequence thereof, withdrawn their patronage from the College, but will still anxiously endeavour, as heretofore, to promote its interests and welfare.

General Shows.—This year the General Show takes place at Dumfries, on the 7th, 8th, and 9th of October; and, from the energy which has already been evinced and from the liberality of the landowners of the district in support of it, an extensive and interesting exhibition is anticipated.

In 1846 the General Show is fixed to take place at Inverness, and in 1847 at Aberdeen.

HIGHLAND AND AGRICULTURAL SOCIETY'S HALL,
EDINBURGH, 25*th June* 1845.

REPORT ON EXPERIMENTS WITH CERTAIN SPECIAL MANURES

By The Turriff Agricultural Association.

Objects of the Experiments.—The Turriff Agricultural Association, at whose instance the experiments now reported were undertaken, had in view the improvement of the agriculture of the district and the diffusion of accurate agricultural knowledge, by means of well arranged and carefully conducted experiments. Duplicates of these experiments were made in several convenient parts of the district, thus giving the members of the association, not merely an opportunity of hearing the results stated and discussed at their meetings, but putting it in their power to visit the progress of the experiments as frequently as they thought fit.

Soils.—The soils in the district of Turriff may be referred to three different classes:—

1*st*, Those derived from the lower beds of the old red sandstone. The old red sandstone appears in this locality chiefly in the form of dark-coloured conglomerates of various degrees of coherency, of dark red sandstones, and of a few beds of slate-clay or shale, containing the well-known Findon ichthyolites. The soils formed from these rocks consequently vary from sandy clay to very open gravel.

2*d*, Soils derived from the greywacke group. The greywacke rocks appear in this district in the form of thin, frequently-alternating beds of greywacke, greywacke-slate, and clayslate, lying generally at high angles, and frequently broken through and traversed by quartz veins. The soils which the greywacke gives rise to are closer and denser than the former, although in very few instances can they be ranked as stiff clays. Occasionally, where the large-grained greywacke has predominated, the weathering resembles that of granite, and the soils are open and porous.

3*d*, Soils derived from various superficial drifts. These soils are more abundant than those which can be clearly referred to the decomposition of the underlying rock. The pebbles of the drifts are all water-worn, principally of primary origin, and appear to have been partly derived directly from primary rocks and partly from the disintegrated conglomerates. The drift soils are the most variable of all in texture—some of them being clay,

some sand, and some barren gravel, with all the intermediate mixtures of these.

4th, A fourth class of soils might be mentioned, viz. the heathy and peaty; but as heath and peat occur, although not by any means with equal frequency, on the three classes above specified, it seems unnecessary to include them.

It was originally intended that a set of similar experiments with extraneous manures should be tried on each of these four different varieties of soil; but it was afterwards found that the funds of the association could only afford three sets, so the peaty soils were excluded, as least characteristic of the district. When a survey of the district was made, no unexceptionable drift soil could be obtained in a centrical situation, and it was therefore resolved that the three localities selected should be, *first*, Findon, in the parish of Gamerie and county of Banff, the soil being a fine old *infield*, derived from the sandstone of the old red above the fish-bed; *2dly*, Slap, in the parish of Turriff, and county of Aberdeen, the soil being a poor gravelly *outfield*, derived from the conglomerate of the old red, inferior to the fish-beds; and, *3dly*, Rothie-brisbane, in the parish of Fyvie and county of Aberdeen, the soil being a fair *outfield*, derived from the greywacke. These soils were fixed on, *first*, because they were obviously derived from the rocks on which they rest, and were free from drift or transported matter; *secondly*, because they were of the most characteristic kinds, each representing areas of considerable extent in the district; and, *thirdly*, because the localities were such, that many of the members of the association, without much trouble, would have frequent opportunities of inspecting the progress of the experiments.

In the course of a preliminary inquiry into the results of experiments with extraneous manures, tried in other parts of the country, the association had occasion to remark that very few of the reports stated the circumstances under which the trials were made with sufficient fulness to enable those ignorant of the particular localities to judge whether similar trials would probably be successful in the Turriff district. It was, therefore, held most expedient to try only such manures as were most attainable, and as had already given profitable results in the hands of the few individuals in the district who had made experiments previous to 1843. It was further thought right that all the circumstances under which the experiments were tried should, as far as possible, be stated, for the purpose of enhancing the value of the results both to the agriculturists of the district and to those unacquainted with its peculiarities.

Examination of the Soils.—For the purpose of giving precise

ideas of the texture of all the soils experimented upon, textural examinations were ordered, so that they could be named without ambiguity, or referred to any of the recent classifications. It was also thought advisable that accurate chemical analyses should be made of the three characteristic soils above mentioned, for the purpose of affording a comparison of the results of the field experiments with the composition of the soils on which the produce grew. These three soils being unmixed with drift, and formed *in situ*, it was thought necessary to have equally minute analyses of their subsoils. The association, in ordering these analyses, had the benefit of the district specially in view; for it is a fair inference that, if the soils are characteristic, the publication of their analyses might, to some extent, supersede the necessity of similar ones, and would, at all events, give additional value to textural examinations of similar soils in the district.

Meteorological Observations.—The influence of climate and of season on vegetation, though generally admitted, has seldom been stated in connexion with experiments with extraneous manures. For the purpose of shewing these circumstances, the association resolved to have a series of meteorological observations taken, during the currency of the experiments, by a careful and competent person, and with unexceptionable instruments. For the sake of being comparable with others, and so made more instructive, the daily observations have been taken on the model of the tables published by the Royal Society of London. The locality fixed on was Darra, and nearly mid-way between Slap and Rothiebrisbane, the two most landward of the localities where the experiments were conducted. The only observation which the association were unable to undertaken was that of the dew-point; but this is the less to be regretted, as it has been ascertained that the dew-point is always but a little above the lowest temperature of the twenty-four hours.

Manures employed for Turnips.—The manures employed were, as has been mentioned, those most easily obtained, most likely to be generally useful, and which had been ascertained by previous trials in the district to be most economical and suitable to its peculiarities. The extraneous manures were purchased of respectable dealers, whose stock had been examined and found good. The particular manures used for turnips were—

1*st*, *Bone-dust*, rather finely crushed, and weighing 54 lbs. per bushel.

2*d*, *Bone-dust with Sulphuric Acid.*—The dry preparation was preferred, being to be had of the manufacturers ready prepared, and of good quality, and also on account of its being capable of being applied by the hand or drill.

3d, Guano.—This was Peruvian of good quality.

4th, Farm-yard Dung.—This was prepared in the way common in the Turriff district, was well fermented, and, in consequence of the amount of turnips consumed on the farms by fattening stock, may be considered as rather better than average quality. The straw consumed was oat-straw; bear-straw in part used as litter; and the horses were fed partly on straw and partly on hay.

The four manures above named were also each used along with half a dose of farm-yard manure, so that the three next applications stand—

5th, Dung and bone-dust.

6th, Dung and bone-dust with sulphuric acid.

7th, Dung and guano.

There were also tried two composts, one of peat, bone-dust, and certain saline manures; the other was a compost of the same kind, only that farm-yard dung was made to substitute the peat.

Permanency of Effect.—The association were particularly desirous of ascertaining, not merely the immediate effect of these substances, but their comparative durability and effect throughout an entire rotation. The common rotation in the district is a five year's one, consisting of—(1,) turnips, (2,) oats or bear, (3,) rye-grass and clover, cut as hay, (4,) pasture, (5,) oats; and it is customary to apply manures only to the green-crop. Now, without entering into the question whether this is or is not the most profitable way of managing a five-course shift, it was thought that important information would be obtained by applying the bone-dust, bone-dust with sulphuric acid, and guano, in the same way as farm-yard manure is usually applied, and also the mixtures of each of these with farm-yard manure, and observing the effect on all the crops of a rotation. Manures that exert all their influence on the crop to which they are applied, and manures that continue for several years to produce smaller but more continued effect, are both valuable; but, to apply each in its most profitable way, we ought to be perfectly conversant with its mode of action.

Provisions against Fallacies.—The only infallible test to which an experiment can be subjected is the balance and the expense of the operations conducted with the requisite care and accuracy on large areas and great quantities of produce; but the difficulty of obtaining exact uniformity of circumstances over a whole field, induced the association to limit the plots to one-eighth of an acre each; and, to afford a check, all the experiments were made in duplicate at each of the three stations.

A comparison of the variations thus produced is calculated to

afford many hints both to those who would institute similar experiments and to those who would draw conclusions from tables where no provision is made for detecting differences.

Periodic Observations and Practical Observations not easily tabulated.—While the weight of produce is the best criterion of success, it was thought advisable to have the experimental plots visited at fixed intervals, and tables of periodic observations made. A comparison of these with the table of results shews that, to judge by the eye, as is frequently done, is a most fallacious proceeding; and that differences so minute as to escape the eye may yet be very considerable on the weighed produce; thus leading to further trials, and, eventually, to improved practice. The periodic observations, however, are in themselves very valuable, for they compel attention to many circumstances liable to escape observation when the final result is only regarded. Thus, for instance, after certain kinds of guano are applied in contact with the seed, the braird is thin and unequal, in consequence, no doubt, of the vitality of some of the seeds having been injured. In like manner, a comparison of the periodic observations with the meteorogical table will enable practical men more clearly to estimate the influences of climate, and to reconcile discordant and perplexing results.* In addition to the tables of periodic observations, are generally notes, containing such remarks on the appearance, quality, condition, &c., of the produce, as appeared at the time of weighing, together with such explanations of any peculiarities or contradictions as at the time suggested themselves to the inspector.

Experiments on particular Crops, the effects being observed only for a single season.—While the established methods of the district, and the want of accurate information regarding the length of time that extraneous manures continue to produce an effect on crops, led the association to attach importance to the series of experiments already referred to, they were by no means ignorant of the value of many soluble saline manures, which, however, in general, do not materially improve any crop but the one to which they are immediately applied. They, therefore, instituted various experiments on these, comparing them with one another, as well as with manures known to be of a more permanent character. Tables of the results of these experiments form the second series of experiments reported. To render these results as definite and instructive as possible, tables of periodic observations were kept, and remarks and

* The Meterological Tables accompanying this report, though evidently constructed with great care, were considered too voluminous to be published in the Society's Transactions.—ED.

observations added. The association did not in these cases think that minutely exact analyses of the soils were called for, but in most cases they made accurate textural examinations, whereby a good estimate of the sort of soils in which the trials were made is conveyed to any stranger conversant with the mechanical conditions of soils.

Conclusions.—It has been the object of the association to bring together a number of facts as free from fallacy as possible; and they hold it safe to communicate facts, and allow every reader to draw his own conclusions. It will be easy for any one into whose hands these tables fall, to arrange the results in a variety of different ways, so that they may be studied from several points of views; and a comparison of these, with the results of similar experiments, conducted in other localities and under other circumstances, can hardly fail to afford interesting matter for reflection, and suggestive of new as well as of modifications of old experiments.

The experiments now reported were with a special view to the practice of the Turriff district, and arranged prior to the publication of the Highland and Agricultural Society's Prize List for 1843, otherwise they might have been shaped more in accordance with the Society's scheme. The association cannot, however, on this account refrain from transmitting results they have found instructive, and which may be useful in adding to the important facts already made public by the efforts of the Great National Agricultural Societies.

FIRST SERIES.—Farm, SLAP; Tenant, Mr WILLIAM MURRAY.

TABLE OF RESULTS OF EXPERIMENTS ON TURNIPS.—*Crop* 1843.

No.	Manures.	Quantity per 1-8th Imp. Acre.	Rate per Imp. Acre.	Cost per Acre. (£ s. d.)	Gross Weight on 1-8th Imp. Acre (ton. cwt. qr. lbs.)	Weight of Bulbs on 1-8th Imp. Acre. (ton. cwt. qr. lbs.)	Weight of Tops and Tails on 1-8th Imp. Acre (cwt. qr. lbs.)	Gross Weight on Imp. Acre. (ton. cwt. qr. lbs.)	Weight of Bulbs on Imp. Acre. (ton. cwt. qr. lbs.)	Weight of Tops and Tails on Imp. Acre. (ton. cwt. qr. lbs.)
1.	Bone-dust, 1st Plot,	2½ bushels.	20 bushels.	2 13 4	1 13 3 20½	1 0 1 20½	13 2 0	13 11 1 24	8 3 1 24	5 8 0 0
	" " 2d Plot,	do.	do.		1 12 2 11	1 6 1 12	6 1 2	13 1 0 0	10 10 3 12	2 10 0 16
2.	Bone-dust, with Sulphuric Acid, 1st,	1½ bushels.	12 bushels.	2 14 0	1 7 1 6	1 3 2 0	3 3 6	10 18 1 20	9 8 0 0	1 10 1 20
	2d,	do.	do.		1 7 1 8	1 3 2 2	3 3 6	10 18 2 8	9 8 0 16	1 10 1 20
3.	Guano, 1st,	cwt. qr. lbs. 0 3 0	6 cwt.	4 4 0	2 1 1 25	1 16 0 20	6 1 5	16 11 3 4	14 9 1 20	2 10 1 12
	" " 2d,	do.	do.		2 1 3 4	1 16 2 11	5 0 18	16 14 1 4	14 13 0 0	2 1 1 4
4.	Farm-yard Manure, 1st,	tons. cwt. lbs. 2 10 0	20 tons.	5 0 0	1 13 3 6	1 9 1 4	4 2 2	13 10 1 20	11 14 1 4	1 16 0 16
	" " 2d,	do.	do.		1 15 3 14	1 10 3 4	5 1 2	14 7 0 0	12 6 1 4	2 2 0 16
5.	No Application.									
6.	Farm-yard Manure,	tons. cwt. lbs. 1 5 0	10 tons.	2 10 0						
	Bone-dust, ... 1st,	1¼ bushels.	10 bushels.	1 6 8	1 11 1 25	1 6 2 14	4 3 11	12 11 3 4	10 13 0 0	1 18 3 4
				£3 16 8						
	" " 2d,	do.	do.		1 13 0 24	1 8 0 20	5 0 14	13 5 2 24	11 5 1 20	2 1 0 0
7.	Farm-yard Manure,	tons. cwt. lbs. 1 5 0	10 tons.	2 10 0						
	Bone-dust with Sul. Acid.	0 0 50	6 bushels.	1 7 0	1 18 2 7	1 13 0 24	5 1 11	15 8 2 0	13 5 2 24	2 2 3 4
				£3 17 0						
	" " 2d,	do.	do.		2 5 3 18	1 19 2 20	6 0 26	18 7 1 4	15 17 1 20	2 9 3 12
8.	Farm-yard Manure, . .	tons. cwt. lbs. 1 5 0	10 tons.	2 10 0						
	Guano, ... 1st,	0 0 42	3 cwt.	2 2 0	2 5 0 22	2 1 1 5	3 3 17	18 1 2 8	16 10 1 12	1 11 0 24
				£4 12 0						
	" " 2d,	do.	do.		2 9 1 14	2 4 3 6	4 2 8	19 15 0 0	17 18 1 20	1 16 2 8
9.	Peat, ...	1¼ tons.	10 tons.	0 10 0						
	Bone-dust.	45 lbs.	6 bushels.	0 16 0						
	Sulphate of Ammonia,	9 lbs. 6 oz.	75 lbs.	0 13 4	1 13 0 22	1 7 2 8	5 2 4	13 5 2 8	11 0 2 8	2 4 1 4
	Nitrate of Soda, . 1st,	7 lbs.	56 lbs.	0 12 0						
				£2 11 4½						
	" " 2d,	do.	do.		1 11 3 12	1 6 2 4	5 1 8	12 14 3 12	10 12 1 4	2 2 2 8
10.	Farm-yard Manure, .	tons. cwt. lbs. oz. 1 5 0 0	10 tons.	2 10 0						
	Bone-dust, ...	0 0 22 8	3 bushels.	0 8 0						
	Sulphate of Ammonia,	0 0 4 11	37 lbs. 8 oz	0 6 8	2 3 1 8	1 17 0 4	6 1 4	17 6 2 8	14 16 1 4	2 10 1 4
	Nitrate of Soda, . 1st,	0 0 3 8	28 lbs.	0 6 0						
				£3 10 8						
	" " 2d,	do.	do.		2 5 1 26	1 18 0 14	7 1 12	18 3 3 12	15 5 0 0	2 18 3 12

, Field slopes to north-east. Drills (27 inches wide) in the same direction. Variety, Green-topped Yellows Turnips.

Periodic Observations.

No. of Experiments	When applied.	Braird appeared	Horse-Hoeing.	Singling.	Second Hoeing.	Setting up.
1	May 25.	June 8.	July 7.	July 7.	July 29.	Aug. 17.
2	May 26.	June 8.	July 5.	July 5.	July 28.	Aug. 17.
3	May 26.	June 8.	July 5.	July 5.	July 26.	Aug. 17.
4	May 26.	June 8.	July 11.	July 11.	July 29.	Aug. 17.
5	May 26.	June 9.	No report.	No report.	No report.	No report
6	May 27.	June 10.	July 11.	July 11.	July 29.	Aug. 17.
7	May 30.	June 10.	July 7.	July 10.	July 29.	Aug. 18.
8	May 27.	June 10.	July 10.	July 11.	July 29.	Aug. 18.
9	*Half* May 27. *Remainder* June 13.	June 19.	July 15.	July 15.	July 29.	Aug. 18.
10	May 30.	June 10.	July 7.	July 7.	July 31.	Aug. 18.

Additional Observations.

First Observation—July 1.

1. Rough blade, 2 inches—healthy colour—inferior to Nos. 2 and 3—plants unequal.
2. Rough blade, 3 inches—advancing rapidly—plants uniform in size—light coloured.
3. Rough blade, 2¼ inches—advancing slowly—broad dark leaf—equal plants.
4. Rough blade, 1¼ inches—better than No. 1—behind Nos. 2 and 3—plants not uniform.
5. Rough blade, ½ inch—small sickly plants.
6. Rough blade, 1¼ inch—similar to No. 1.
7. Rough blade, 1¾ inches—rapid growth—light narrow leaves—regular sizes.
8. Rough blade, 1½ inch—advancing slowly—dark, healthy, equal plants.
9. Rough blade, ¾ inch—although late, rapidly progressing.
10. Rough blade, 1¾ inch—very good, dark, equal plants.

Second Observation—July 15.

1. Rough blade, 4¼ inches.
2. Do. 4¾ do.
3. Do. 5½ do.
4. Do. 4 do.
5. Do. little difference.
6. Do. 3½ inches.
7. Do. 4½ do.
8. Do. 6 do.
9. Do. 4 do.
10. Do. 5½ do.

Third Observation—July 22.

1. Advancing slowly, but healthy—plants not uniform.
2. Remarkably improved, long, narrow, light-coloured leaves—plants uniform.
3. Advancing most—best on the field—very dark broad leaves—uniform.
4. Better than No. 1, but backward.
5. No difference—sickly plants—not fit for the hoe,

6. Considerably improved—better than No. 1—more uniform.
7. Not so good as last—light coloured—and smaller leaves.
8. Very luxuriant—next to No. 3—scarcely so dark.
9. Late—growthy—uniform.
10. Better than No. 7—healthy—plants uniform.

Fourth Observation—August 19.

1. Good—advancing more rapidly than formerly.
2. Not so dark nor large foliage—earlier—some tendency to flower.
3. Remarkably fine—dark strong leaves.
4. Similar to No. 1—improving much.
5. Beginning to disappear.
6. Not so early as No. 1.
7. Foliage not so strong as No. 8—bulbs much improved.
8. Best on the field—very strong leaves—and close between drills.
9. Advancing rapidly.
10. Rather better than No. 7—foliage darker.

Fifth Observation—September 1.

1. Very growthy.
2. No advance on leaves—bulbs much improved—rather inclined to flower—least appearance on the field.
3. Most luxuriant.
4. Similar to No. 1—advancing rapidly.
5. Same as formerly.
6. Good.
7. Little advance—rather faded—bulbs good—early.
8. Next to No. 3—very close.
9. Considerable improvement.
10. More growthy than No. 7.

The foliage of the turnips grown after bone-dust with sulphuric acid is of a light green tint. This substance appears to have brought the plants earlier to maturity, diminished the size of the foliage, and made the leaves long and narrow. The bulbs grown from it are very small at the necks, and take a firm hold of the ground; the tails are not so thick as usual, but are tough and fibrous. A good many turnips throughout the field are beginning to run to flower in consequence of the dry warm weather.

Sixth Observation—October 6.

1. A little improved—good.
2. No advance—worst on the field—small bulbs, but with smooth skin.
3. Much mildewed—early leaves fading—rather greatest tendency to flower—large bulbs.
4. No advance—much faded—a little mildewed—scarcely so good as No. 1.
5. Plants have all disappeared.
6. Very good—fading.
7. Similar to No. 1—much better than No. 2.
8. Next to No. 3—a little mildewed, and much faded.
9. Progressing rapidly—leaves green.
10. More growthy than No. 7—darker—very good.

In consequence of the dry warm weather, the turnips over the whole field are fading much. Those sown later on the same field are continuing to grow rapidly to foliage—so much so that, from appearance, the experiments would have suited the season better had they been made eight days later. A good many have run to flower. Of the manures, guano alone appears to have a tendency to cause turnips to flower. At the time of hoeing, it was remarked that the soil was firmer where bone-dust and bone-dust with sulphuric acid had been employed than on other parts of the field.

Observations at the time of Weighing the Produce.

1. Only three decayed turnips on both the plots—bulbs hard, clean, and of a yellow colour—tops dark green.
2. Bulbs smaller, hard, and clean—fine small necks—difficult to detach from the ground.
3. Plants very uniform in size—much improved in firmness, and depth of colour, since last examination.
4. Plants very variable in size—a great majority very small.
5. No turnips remaining—all died out.
6. Size of bulbs very various—some large and some very small.
7. A good equal crop—bulbs hard.
8. By far the largest and most uniform crop—a few of the bulbs rotten.
9. Remarks omitted.
10. Very good—sizes uniform—bulbs deep coloured.

There was a tendency to flower over the field, but not more than about 240 plants per acre. The weighing having occupied a good many days, and the weather being exceedingly mild, a second growth set in, giving a greater weight to the tops and less weight to the bulbs last weighed.

Observations on Quality of Produce.

The inspector, along with other three practical farmers, examined the turnips on the several plots, for the purpose of ascertaining the comparative solidity, sweetness, and any other difference that might be perceptible. A good many bulbs, of uniform size and outward appearance, were selected from each of the plots, and from three to five of each were cut up, tasted, and carefully examined. The following results were obtained:—

1. Bulbs juicy—rather sweet—hard—yellow.
2. Not nearly so juicy or sweet—spongy.
3. Juicy—soft—not very sweet. These bulbs would, probably, not stand much frost, and might be liable to rot from the bottom, as appeared in one or two cases.
4. By far the sweetest—juicy and hard.
5. No Turnips.
6. Hard, and similar to No. 1.

7. Tender—rather sweet—not very juicy.
8. Most spongy—soft—not so juicy as No. 3—little taste.
9. Remarkably tender—juicy—not very sweet.
10. The hardest, most juicy, and sweetest on the field.

Crop 1844.

TABLE of RESULTS ON OATS.—SECOND YEAR OF THE ROTATION.

No	Manures	Weight of Straw and Chaff p. 1/4th Imp. Acre	Quantity of Dressed Grain p. 1/4th Imp. Acre	Weight of Light Grain on 1/4th Imp. Acre	Weight of Straw and Chaff per Imp. Acre.	Quantity of Dressed Grain p. Imp. Acre	Weight per Bushel	Weight of Light Grain p. Imp. Acre	Increase of Straw per Imp. Acre	Increase of Dressed Grain per Imp. Acre	Increase of Light Grain
		lbs	bs lbs	lbs	cwt q lbs	qr bus lbs	lbs	lbs	cwt qr lbs	qr bus lbs	lbs
1	Bone-dust, .	710	10 4	20½	25 1 12	5 0 16	40¾	82	9 1 26	1 7 30¾	40
2	Bone dust and Sulph. Acid,	568	8 12½	23	20 1 4	4 1 10	40	92	4 1 18	1 0 21	50
3	Guano, . .	600¼	8 35¼	11	21 1 23	4 3 21	40¼	44	5 2 9	1 2 35	2
4	Farm-yd. Man.	813¼	11 14	14½	29 0 5	5 5 15¾	39½	59	13 0 19	2 4 30	17
5	No application,	444½	6 6½	10½	15 3 14	3 0 26	39	42			
6	Fm.-yd. Man. & Bone-dust,	762¼	10 8¾	13	27 0 25	5 0 35	41	52	11 1 11	2 0 9	10
7	Fm.-yd. Man. Bone-dust, & Sulph. Acid.	807¼	11 3¼	15½	28 3 9	5 4 13	40¾	62	12 3 23	2 3 27¼	20
8	Fm.-yd. Man. and Guano,	938¼	12 24½	16	33 2 3	6 2 16	40¾	64	17 2 17	3 1 31	22
9	Peat & Saline Manures, .	615	8 30½	12½	21 3 24	4 3 5	40½	50	6 0 10	1 2 18	8
10	Fm.-yd. Man. & Sal. Man.	847¼	11 36¼	16	30 1 1	5 7 22	41	64	14 1 15	2 6 37	22

The corn was cut on 24th September; led 9th October; thrashed 19th October. It was of the variety of oats called "Scots barley."

There was scarcely any difference in the samples of dressed grain with respect to colour—all light coloured, free from seeds of weeds. The weightiest samples had least greens. Scarcely any difference could be detected in the weight of the straw, with the exception, perhaps, of No. 5, which was very short, wiry, and contained some greens—requiring to be thrashed out early, as the straw could not be well win, (dried.)

PERIODIC OBSERVATIONS, &c.

1. Equal to No. 3.
2. Scarcely so good as No. 6.
3. Inferior to No. 6.
4. The best.
5. This and No. 9 decidedly the worst—short (8 inches)—half shot—and ear small.
6. Not nearly so good as No. 8.
7. Third best.
8. Next to No. 7, but later.
9. Same as No. 5.
10. Second best.

September 4.

1. Advancing rapidly.
2. Not so good—rather earlier.
3. Similar to No. 1.
4. By far the best—dark and thick.
5. Very inferior.
6. Second best—thick—strong—earlier than No. 9.
7. Nearly as good as No. 8.
8. Very good—progressing rapidly, but latest.
9. Not so good as No. 1—advancing much.
10. Scarcely so good at last.

Little difference in earliness can be observed. The crop averages 3½ feet long; small head of grain, and straw wiry.

Observation when Cut—September 24.

1. Good, and equally ripened.
2. Not so well ripened—a good many greens.
3. Better ripened than last.
4. Equally ripened—thick.
5. Very short and not well ripened.

6.
7. } Good, and equally ripened.
8.

9. Not much better than No. 5—nearly as many greens.
10. Same as Nos. 6, 7, and 8.

The sole of new grass appears pretty similar on all the plots, and looking fair, with the exception of No. 5.

Farm, FINDON; Tenant, Mr WILLIAM DOCKAR.

TABLE OF RESULTS OF EXPERIMENTS ON TURNIPS.—*Crop* 1843.

No.	Manures.	Quantity per 1 8th Imperial Acre.	Rate per = Imperial Acre.	Cost per Acre.	Gross Weight on 1-8th Imperial Acre.	Weight of Bulbs on 1-8th Imperial Acre.	Weight of Tops and Tails on 1-8th Imperial Acre.	Gross Weight on Imperial Acre.	Weight of Bulbs on Imperial Acre.	Weight of Tops and Tails on Imperial Acre.
				L. s. d.	tons. cwt. qr. lbs.	tons. cwt. qr. lbs.	cwt. qr. lbs.	tons. cwt. qr. lbs.	tons. cwt. qr. lbs.	tons. cwt. qr. lbs.
1.	Bone-dust, ... 1st Plot,	2½ bushels.	20 bushels.	2 13 4	1 5 1 12	1 1 3 4	3 2 8	10 2 3 12	8 14 1 4	1 8 2 8
	.. . . 2d Plot,	do.	do.		1 13 0 6	1 8 2 26	4 1 8	13 4 1 20	11 9 3 12	1 14 2 8
2.	Bone-dust with Sulphuric Acid, 1st	1½ bushels.	12 bushels.	2 14 0	1 5 3 12	1 2 3 12	3 0 0	10 6 3 12	9 2 3 12	1 4 0 0
	.. .. .. 2d	do.	do.		1 6 3 20	1 3 2 24	3 0 24	10 15 1 20	9 9 2 24	1 5 2 24
3.	Guano, ... 1st	cwt. qrs. lbs. 0 3 0	6 cwt.	4 4 0	2 0 2 20	1 14 1 0	6 1 20	16 5 1 20	13 14 0 0	2 11 1 20
	.. . . 2d	0 3 0	do.		1 19 3 24	1 14 1 4	5 2 20	15 19 2 24	13 14 1 4	2 5 1 20
4.	Farm-yard Manure, ... 1st	tons. cwt. lbs. 2 10 0	20 ton.	5 0 0	1 5 1 20	1 0 3 4	4 2 16	10 3 1 20	8 6 1 4	1 17 0 16
	.. .. 2d	2 10 0	do.		1 7 3 16	1 2 3 16	5 0 0	11 3 0 16	9 3 0 16	2 0 0 0
5.	No Application, ... 1st				1 6 0 4	1 1 1 20	4 2 12	10 8 1 4	8 11 1 20	1 16 3 12
	.. . . 2d				1 1 0 20	0 17 0 12	4 0 8	8 9 1 20	6 16 3 12	1 12 2 8
6.	Farm-yard Manure, ... Bone-dust, ... 1st	1 5 0 1¼ bushels.	10 tons. 10 bushels.	2 10 0 1 6 8 L.3 16 8	1 4 0 8	0 19 3 24	4 0 12	9 12 2 8	7 19 2 24	1 12 3 12
	.. . . 2d	do.	do.		0 19 2 0	0 16 2 4	2 3 24	7 16 0 0	6 12 1 4	1 3 2 24
7.	Farm-yard Manure, ... Bone-dust and Sulphuric Acid, 1st	tons. cwt. lbs. 1 5 0 0 0 56¼	10 tons. 6 bushels.	2 10 0 1 7 0 L.3 17 0	1 7 1 16	1 1 2 12	5 1 16	10 19 0 16	8 12 3 12	2 3 0 16
	.. .. .. 2d	do.	do.		0 19 0 12	0 16 1 0	2 3 12	7 12 3 12	6 10 0 0	1 2 3 12
8.	Farm-yard Manure, ... Guano, ... 1st	1 5 0 0 0 42	10 tons. 3 cwt.	2 10 0 2 2 0 L.4 12 0	1 19 3 4	1 12 2 16	7 0 16	15 18 1 4	13 1 0 16	2 17 0 16
	.. . . 2d	do.	do.		1 13 1 24	1 8 0 16	5 1 8	13 7 2 24	11 5 0 16	2 2 2 8
9.	Peat, ... Bone-dust, ... Sulphate of Ammonia, ... Nitrate of Soda, ... 1st	tons. cwt. lbs. oz 1 5 0 0 0 0 45 0 0 0 9 6 0 0 7 0	10 tons. 6 bushels. 75 lbs. 56 lbs.	0 10 0 0 16 0 0 13 4½ 0 12 6 L.2 11 10½	1 12 0 8	1 6 1 12	5 2 24	12 16 2 8	10 10 3 12	2 5 2 24
	.. . . 2d	do.	do.		1 8 2 16	1 4 0 24	4 1 20	11 9 0 16	9 13 2 24	1 15 1 20
10.	Farm-yard Manure, ... Bone-dust, ... Sulphate of Ammonia, ... Nitrate of Soda, ... 1st	1 5 0 0 0 0 22½ 0 0 0 4 11 0 0 3 8	10 tons. 3 bushels. 37½ lbs. 28 lbs.	2 10 0 0 8 6 0 6 8½ 0 6 0 L.3 10 8½	1 11 1 8	1 5 2 0	5 3 8	12 10 2 8	10 4 0 0	2 6 2 8
	.. . . 2d	do.	do.		1 5 0 0	1 0 0 16	4 3 12	10 0 0 0	8 1 0 16	1 18 3 12
11.	Farm-yard Manure, ... 1st	tons. c. lb. 2 10 0	20 tons.	5 0 0	1 0 1 4	0 17 0 9	3 0 24	8 2 1 4	6 16 2 9	1 5 2 24
	.. .. 2d	do.	do.		1 6 1 22	1 2 1 12	4 0 8	10 11 2 8	8 14 3 12	1 12 2 8

*** Field slopes to north-west. Drills (28 inches wide) in the same direction. Variety, Green topped Yellow Turnips.

Periodic Observations.

No. of Exp.	When applied.	Braird appeared.	Horse-Hoeing.	Singling.	Second Hoeing.	Setting up.	*First* Observation, June 30.	*Second* Observation, August 2.	*Third* Observation, August 18.	*Fourth* Observation, October 4.
1.	June 5.	June 15.	No report.	July 11.	No report.	Not set-up.	Good braird—thick.	Good.	Good—dark.	Good—and advancing.
2.	June 5.	June 15.	Do.	July 11.	Do.	Do.	Do.	Considerably better.	Rather better—earlier.	Not so good—no advance.
3.	June 5.	June 15.	Do.	July 11.	Do.	Do.	Do., and darker in colour.	Remarkably fine.	Best on the field—very luxuriant.	Evidently best.
4.	June 5.	June 15.	Do.	July 11.	Do.	Do.	Rough leaf—1 inch.	Worst.	As good as No. 10.	Fair turnips.
5.	May 24.	June 10.	Do.	July 5.	Do.	Do.	Rough leaf—1¼ inch thick, and as good as several of the others.	As good as No. 1.	Scarcely so good.	No perceptible difference from last observation.
6.	May 24.	June 10.	Do.	July 5.	Do.	Do.	Rough leaf—2¼ inch—similar to No. 1—thick.	Better than No. 1.	Better than No. 10.	Good—and advancing.
7.	May 24.	June 10.	Do.	July 5.	Do.	Do.	Rough leaf—2¼ inch—leaves light in colour—very luxuriant—thick.	Rather better than No. 6.	Rather better than No. 6.	Similar to No. 6.
8.	May 24.	June 10.	Do.	July 5.	Do.	Do.	Rough leaf—2¾ inch—luxuriant—leaf dark—thick.	Best.	Next best to No. 8.	Not so good as No. 8—second best.
9.	May 24.	June 10.	Do.	July 5.	Do.	Do.	Rough leaf—2½ inch—very thick, and fully earlier than No. 6.	Very fine.	Very rich.	Good—little progress.
10.	May 24.	June 10.	Do.	July 5.	Do.	Do.	Rough leaf—2½ inch—thick and luxuriant.	Perhaps a trace inferior to No. 6.	Scarcely so good as No. 9.	Similar to No. 9.

Additional Observations.

June 30.—The plants of the first sowing, viz., from No. 5 to No. 10, are very healthy and growing. Turnips of another sort, sown the same day, side by side with the experimental plots, but not so thickly, are much later, and not nearly so equal a braird. The second sowing, viz., from No. 1 to No. 5, are much later, from the sowers having given too much seed to the first half; hence the experimenter had to wait till more seed could be got out of the same stock as the first. The land is a good deal infested by "charlock."

August 18.—The turnip tops look remarkably fine and healthy. The drills should perhaps have been 31 inches wide instead of 28, and the turnips hoed 9 inches apart, instead of 6 inches. The disease called "fingers and toes" prevails among many of the bulbs, causing them and the rootlets to swell and excoriate. On cutting into the bulbs and excrescences, no insect was found, even when examined under the microscope. A small beetle, about one-quarter inch long, a swift runner, and of a dark brown colour, was always found in the earth, in the immediate vicinity of the diseased plant. In many cases a small wire-worm, and several other worms were found among the dung under the plant.

Several of the turnips are withering away. No difference could be perceived, as to size, between the diseased turnips and the sound.

The turnips on this farm are subject to this disease almost every year.

October 4.—A good many of the earliest sown turnips have run to flower, but it cannot be affirmed that any of the manures applied have tended to encourage flowering. None of the latest sown have run to flower.

Observations at the time of Weighing the Produce.

The turnips on all parts of the field are more or less affected by the disease called "fingers and toes," so much so, that many of them are completely decayed. Early in the season, observed the turnips affected, and perceived many of them all along dying out; but it could not be told, previous to this time, which experimental plot was worst; because, unless those turnips which are quite dead, it cannot be known to what extent they are diseased until they are pulled. On the date of this observation, (Jan. 23,)

however, it was found that the turnips upon the different experimental plots were more or less affected.

1. Eight turnips in 108 were completely rotten.
2. Thirty-three turnips in 103 were completely rotten—smaller generally than last.
3. Ten in 110 completely rotten—largest and freshest.
4. Much wasted—fully as much affected as any of the others.
5. Forty-two rotten in 142—similar to last.
6. Sixty-one rotten in 161.
7. Much smaller—more wasted.
8. Larger—about one-fifth of the large turnips and all the small ones diseased—liable to flower.
9. More of them shot—many wasted.
10. Not many shot, but equally wasted.

Crop 1844.

Table of Results on Oats.—Second Year of the Rotation.

No.	Manures.	Weight of Straw and Chaff per 1-4th Imp. Acre.	Quantity of Dressed Grain per 1-4th Imperial Acre.		Weight of Light Grain per 1-4th Imp. Acre.	Weight of Straw and Chaff per Imperial Acre.			Quantity of Dressed Grain per Imp. Acre.			Weight per Bushel.	Weight of Light Grain per Imp. Acre.	Increase * and Decrease † of Straw per Imp. Acre.			Increase of Dressed Grain per Imp. Acre		
		lbs.	bu.	lbs.	lbs.	cwt.	qr.	lb.	qr.	bu.	lbs.	lbs.	lbs.	cwt.	qr.	lbs.	qr.	bu.	lb.
1	Bone-dust, .	1099	10	36½	18	39	0	4	5	3	24½	40½	72	†3	1	8	1	1	9½
2	Bone-dust and Sulph. Acid,	1054	10	21½	13½	37	2	16	5	2	5	40½	54	†4	2	24	0	7	30½
3	Guano, . .	1273	12	7½	16	45	1	24	6	0	3	40¼	64	*3	0	12	1	6	15
4	Farm-yd. Man.,	1335½	12	27¾	18¾	47	2	21	6	2	30	40½	75	*5	1	9	2	0	15
5	No application,	1186	8	24	17½	42	1	12	4	2	15	40½	70						
6	Fm.-yd. Man. & Bone-dust,	1434	12	0	23	51	0	24	6	0	0	40	92	*8	3	12	1	5	25
7	Fm.-yd. Man. Bone-dust, & Sulph. Acid,	1162	11	24½	25½	41	2	0	5	6	17	40½	102	†0	3	12	1	4	2
8	Fm.-yd. Man. and Guano,	1254	12	1¼	15¾	45	0	26	6	0	5	40½	53	*2	3	14	1	5	30½
9	Peat & Saline Manures, .	1302¾	10	25½	21½	46	2	3	5	2	21	40½	86	*4	0	19	1	0	6
10	Fm.-yd. Man. & Saline Man.	1375½	12	18	21½	49	0	14	6	1	31½	40½	86	*6	3	2	1	7	16½

The corn was cut on 23d September; led 4th October; thrashed 25th October; and, consequently, the straw was not well dried.

Periodic Observations.

First Observation—July 15.

1, 2. Equal to No. 10.
3. Same as No. 4.
4. Thirty inches in length—equal to Nos. 6 and 7—blade above the ear.
5. Twenty-seven inches in length—same as No. 10.
6. Thirty inches—better, and not so far advanced as No. 7—thicker.
7. Twenty-seven inches—same as No. 8.
8. Twenty-seven inches—more luxuriant than Nos. 9 or 10.
9, 10. Twenty-four inches in length—full of weeds.

Second Observation—August 3.

1, 2. Three feet in length—not so luxuriant as any of the others.
3. Four feet—closer and more luxuriant than any of the others.
4. Four feet—closer and more luxuriant than any of the others.
5. Three feet six inches—opener than No. 10.
6. Three feet nine inches—better than No. 8.
7. Three feet six inches—better than No. 8.
8. Three feet six inches—closer than No. 10.
9, 10. Three feet—not close.

Third Observation—September 23.

1. Rather inferior to No. 9.
2. Rather inferior to No. 9.
3. Lodged—rather inferior to No. 4.
4. Lodged—equal to No. 6.
5. Equal to No. 10.
6. Lodged—much better than No. 9.
7. Taller and better than No. 9.
8. Rather better than No. 9.
9. Middling.
10. Middling.

Farm, ROTHIE-BRISBANE; Tenant, CHARLES CHALMERS, Esq. of Monkshill.

TABLE OF RESULTS OF EXPERIMENTS ON TURNIPS.—*Crop* 1843.

No	Manures.	Quantity per 1-8th Imp. Acre.	Rate per Imp. Acre.	Cost per Acre	Gross Weight on 1-8th Imp. Acre.	Weight of Bulbs on 1-8th Imp. Acre.	Weight of Tops and Tails on 1-8th Im. Acre	Gross Weight on Imp. Acre.	Weight of Bulbs on Imp. Acre.	Weight of Tops and Tails on 1-8th Imp. Acre.
				L. s. d.	tons. cwt. qrs. lbs.	tons. cwt. qrs. lbs.	cwt. qrs. lbs.	tons. cwt. qrs. lbs.	tons. cwt. qrs. lbs.	tons. cwt. qrs. lbs.
1.	Bone-dust, 1st Plot,	2½ bushels.	20 bushels.	2 13 4	1 6 0 4¼	1 2 2 5¼	3 1 26	10 8 1 8	9 0 1 14	1 7 3 12
	" " 2d Plot,	do.	do.	do.	1 7 2 23⅛	1 6 0 1⅝	1 2 23⅜	11 1 2 21	10 8 0 13	0 13 2 9
2.	Bone-dust, with Sulphuric Acid, 1st,	1½ bushels.	12 bushels.	2 14 0	1 16 2 13½	1 12 6 7¼	4 2 6¾	14 12 3 24	12 16 2 2	1 16 1 22
	2d,	do.	do.	do.	1 18 0 25¼	1 13 1 16¾	3 3 9	14 17 3 10	13 7 0 22	1 10 2 16
3.	Guano, ... 1st,	cwt. qrs. lbs. 0 3 0	6 cwt.	4 4 0	2 0 3 25	1 16 3 1¼	4 0 23¼	16 7 3 4	14 14 0 14	1 13 2 18
	" " 2d,	do.	do.	do.	2 2 0 7¾	1 18 1 6	3 3 1¾	16 16 2 6	15 6 1 20	1 10 0 14
4.	Farm-yard Manure, 1st,	tons. cwt. lbs. 2 10 0	20 tons.	5 0 0	1 8 0 2¾	1 5 0 4¼	3 1 26	11 8 0 22	10 0 1 10	1 7 3 12
	" " 2d,	do.	do.	do.	1 9 1 22¾	1 5 2 20¼	3 3 2½	11 15 2 14	10 5 1 22	1 10 0 20
5.	No Application, . . .	"	"	"	0 0 1 2	0 0 0 22¾	0 0 7¼	0 2 0 16	0 1 2 14	0 0 2 2
6.	Farm-yard Manure, .	tons. cwt. lbs. 1 5 0	10 tons.	2 10 0						
	Bone-dust, . . . 1st,	1¼ bushels.	10 bushels.	1 6 8	1 11 2 17¾	1 8 1 11¼	3 1 6½	12 3 1 2	11 6 3 6	1 6 1 24
				£3 16 8						
	" " 2d,	do.	do.	do.	1 9 2 27¼	1 6 1 14¼	3 1 13	11 17 3 22	10 11 0 2	1 6 3 20
7.	Farm-yard Manure, . .	tons. cwt. lbs. 1 5 0	10 tons.	2 10 0						
	Bone-dust, with Sul. Acid,	0 0 50	6 bushels.	1 7 0	1 6 2 20¼	1 11 0 15¼	4 1 5	14 3 1 22	12 9 0 10	1 14 1 12
				£3 17 0						
	" " 2d,	do.	do.	do.	1 14 0 23¾	1 10 1 1¼	3 3 22	13 13 2 22	12 2 0 14	1 11 2 8
8.	Farm-yard Manure, . .	tons. cwt. lbs. 1 5 0	10 tons.	2 10 0						
	Guano, ... 1st,	0 0 42	3 cwt.	2 2 0	2 1 3 4¾	1 18 0 17¾	3 2 15	16 14 1 10	15 5 1 2	1 9 0 8
				£4 12 0						
	" " 2d,	do.	do.	do.	2 0 0 25¼	1 19 1 14¾	3 1 13	16 1 3 6	14 15 0 6	1 6 3 20
9.	Peat, ...	tons. cwt. lbs. oz. 1 5 0 0	10 tons.	0 10 0						
	Bone-dust, ...	0 0 45 0	6 bushels.	0 16 0						
	Sulphate of Ammonia, .	0 0 9 6	75 lbs.	0 13 4½	1 6 0 26	1 2 2 24¾	3 2 1¼	10 9 3 12	9 1 3 2	1 8 0 10
	Nitrate of Soda, . 1st,	0 0 7 0	56 lbs.	0 12 0						
				£2 11 4½						
	" " 2d,	do.	do.	do.	1 5 0 1¼	1 2 1 3¾	2 2 25½	10 0 0 10	8 18 1 2	1 1 3 8
10.	Farm-yard Manure, . .	tons. cwt. lbs. oz. 1 5 0 0	10 tons.	2 10 0						
	Bone-dust, ...	0 0 22 8	3 bushels.	0 8 0						
	Sulphate of Ammonia, .	0 0 4 11	37½ lbs.	0 6 8½	1 7 1 6½	1 4 0 6¾	3 0 15	10 18 1 22	9 13 1 14	1 5 0 8
	Nitrate of Soda, . 1st,	0 0 3 8	28 lbs.	0 6 0						
				£3 10 8½						
	" " 2d,	do.	do.	do.	1 6 3 20	1 3 3 11¼	3 0 8½	10 15 1 20	9 10 3 8	1 4 2 12

*** Field slopes to east south-east. Drills (27 inches wide) in the same direction. Variety, Green-topped Yellows Turnips.

PERIODIC OBSERVATIONS.

No. of Exper.	When applied.	Braird appeared.	Horse-Hoeing.	Singling.	Second Hoeing.	Setting up.	First Observation, July 7.	Second Observation, July 14	Third Observation, July 21.	Fourth Observation, July 28.	Fifth Observation, August 2.	Sixth Observation, September 21.
1.	June 16.	No Report.	No Report.	July 20.	No Report.	No Report.	Rough leaf, 1 inch, plants very thick.	Rough leaf, $1\frac{1}{4}$ inch long.	Not looking well.	Not much improved since last obser.	Good, equal.	Small bulbs, good.
2.	June 16.	Do.	Do.	July 15.	Do.	Do.	Rough leaf, $1\frac{1}{2}$ inch, regular, & plants very fine.	Rough leaf, $2\frac{1}{2}$ in., equal, advancing fast.	Rapidly advancing.	Much improved, last observation.	Better and thicker.	Better, foliage fuller, bulbs large & uniform in size.
3.	June 16.	Do.	Do.	July 15.	Do.	Do.	Rough leaf, $1\frac{1}{4}$ inch, not so good as No. 2.	Rough leaf, $2\frac{3}{4}$ in., very dark colour.	Improving & dark coloured.	Looking very well, dark.	Better than last, darker, broader leaved	Considerably better both in bulbs & foliage.
4.	June 16.	Do.	Do.	No Report.	Do.	Do.	Rough leaf, $\frac{1}{4}$ in. dark colour.	Little difference since last observation.	No advance.	A little improved.	Very small, stunted.	Plants have disappeared.
5.	June 16.	Do.	Do.	July 20.	Do.	Do:	Rough leaf, $\frac{7}{8}$ in. plants irregular.	Rough leaf, 2 inches.	Little advan. since the last observation.	Similar to No. 1, little progress.	Like No. 1, but irregular.	Not so good as No. 2.
6.	June 16.	Do.	Do.	July 20.	Do.	Do.	Rough leaf, $1\frac{1}{2}$ inch, plants very thick.	Rough leaf, $2\frac{1}{4}$ in., very good.	Advancing slowly.	Considerable improvement.	Same as No. 5.	Similar to No. 1.
7.	June 16.	Do.	Do.	July 15.	Do.	Do.	Rough leaf, $1\frac{1}{2}$ in., plants thick and regular.	Rough leaf. $2\frac{3}{4}$ in., very good.	Little difference since last observation.	Much the same as at last observation.	Much better than last observation.	Rapidly improving.
8.	June 16.	Do.	Do.	July 21.	Do.	Do.	Rough leaf, $1\frac{1}{8}$ inch, rather dark in colour.	Rough leaf, $2\frac{1}{2}$ in., very unequal in size.	Similar to No. 3, dark & looking well.	Adv. rapidly, leaves broad and healthy.	Rather stronger and darker.	Best and largest bulbs.
9.	June 17.	Do.	Do.	July 21.	Do.	Do.	Rough leaf, 1 in. very dark in colour.	Rough leaf, $1\frac{1}{4}$ in., very unequal.	Much improved since last obser.	Not much growth.	Not so good as No. 1.	Not equal to No. 1, much later.
10.	June 17.	Do.	Do.	July 21.	Do.	Do.	Rough leaf, $\frac{3}{4}$ in. dark coloured.	Rough leaf, $1\frac{1}{2}$ inch, unequal.	Do.	Do.	Same as last.	Do.

Observations on Quality of Produce.

At the time of weighing, an examination was made of the hardness, sweetness, &c., of the bulbs, and afforded to the inspector results precisely similar to those already stated regarding the produce at Slap, p. 10.

Crop 1844.

TABLE OF RESULTS ON OATS.—SECOND YEAR OF THE ROTATION.

No.	Manures.	Weight of Straw and Chaff p 1 4th imp Ac	Quantity of Dressed Grain per 1 4th Imp Acre	Weight of Light Grain per 1 4th Imp Acre	Weight of Straw and Chaff per Imp Acre	Quantity of Dressed Grain per Imp Acre	Weight per Bushel.	Weight of Light Grain p Im Ac	Increase of Straw per Imp Acre	Increase of Dressed Grain per Imp Acre	Increase of Light Grain
		lbs	bu lbs	lbs	cwt qr lb	qr bu lbs	lbs	lbs	cwt qr lb	qr bu lbs	lbs
1	Bone-dust, .	621½	7 37½	13	22 0 22	3 7 33	39	42	8 1 26	1 5 7	22
2	Bone-dust and Sulph. Acid,	557	8 22	10¾	19 3 7	4 2 9	39½	43	6 0 11	1 7 22½	23
3	Guano, . .	604	8 34	8½	21 2 8	4 3 7	39'	34	7 3 12	2 0 21	14
4	Farm-yd. Man.	739¼	9 38	11	26 1 16	4 7 33	39¾	44	12 2 20	2 5 7	24
5	No application,	384	4 26	5	13 2 24	2 2 26	39	20			
6	Fm.-yd. Man. & Bone-dust,	658½	8 36½	9	23 2 4	4 3 29	39	36	9 3 8	2 1 3	16
7	Fm.-yd. Man. Bone-dust, & Sulph. Acid,	623¼	8 18	6½	22 1 2	4 1 32'	39	26	8 2 6	1 7 6½	6
8	Fm.-yd. Man. and Guano,	788	9 3½	21	28 0 16	4 4 13	38½	84	14 1 20	2 1 25½	64
9	Peat and Saline Manures,	480	6 6	17	15 1 12	3 0 24	38	68	1 2 16	0 5 36	48
10	Fm.-yd. Man. & Sal. Man.	727	8 10½	10½	25 3 21	4 1 4'	37½	42	13 1 0	1 6 16	22

The corn was cut on 23d September, led 28th, and thrashed 22d October; and, consequently, the crop was not well dried.

PERIODIC OBSERVATIONS.

July 19, 1844.

1. Thin, short, but uniform—dark green.
2. Rather thicker, lighter in colour, and earlier.
3. Fair, dark, and later than the last.
4. Not so good as No. 3.
5. Very bad, by far the worst in the field.
6. Rather better than No. 4—later.
7. Equal to No. 3—not so dark, and earlier.
8. Fully better than No. 3—dark green.
9. Similar to No. 1, but scarcely so good.
10. Equal to No. 1.

The differences are not very great; those that had farm-yard manure better than the rest. In all the plots the growth is rather unequal, with a second growth (greens) coming up.

October 22, 1844.

The oats after Nos. 5, 9, and 10 had a good many greens amongst them; but little difference could be perceived amongst the others.

SECOND SERIES.—Farm, DARRA; Tenant, Mr ROBERT O. YOUNG.

TABLE OF RESULTS OF EXPERIMENTS ON POTATOES.—*Crop* 1843.

No.	Manures.	Quantity per Imp. Acre.	Cost per Imp. Acre.	Weight of Crop per Imp. Acre.	Remarks.
			L. s. d.	tons. cwt. qr. lbs.	
1.	Farm-yard Manure, .	10 tons.	2 10 0		
	Guano, ...	2 cwt.	1 8 0		
	Sulphate of Magnesia,	1 cwt.	0 14 0	5 2 0 16	Generally of a large size.
			£4 12 0		
2.	No application, . .	...	...	2 3 0 16	Small size.
3.	Farm-yard Manure, .	10 tons.	2 10 0		
	Bone-dust and Sulphuric Acid, .	8 bush.	1 16 0		
	Sulphate of Magnesia	1 cwt.	0 14 0	2 19 0 0	Good size, but not quite so large as No. 1.
			£5 0 0		

*** Field without slope. Direction of the drills, east and west.

PERIODIC OBSERVATIONS.

No.	Kind—Whole or Cut.	When Planted.	First appeared.	First Hoed.	Horse-hoed and Set-up	Came to Flower.	When taken up, & Quantity
1.	Round red—cut.	May 17.	June 20.	July 4.	July 15.	No report.	No report.
2.	Do. Do.	May 17.	June 22.	July 4.	July 15.	Do.	Do.
3.	Do. Do.	May 17.	June 20.	July 4.	July 15.	Do.	Do.

Farm, DARRA.

TABLE OF RESULTS OF EXPERIMENTS ON OATS.—*Crop* 1843.

(*After Turnips—Second crop in the Rotation.*)

No.	Manures.	Quantity per 1-8th Imp. Acre.	Cost per 1-8th Imp. Ac.	Rate per Imp. Acre.	Cost per Imp. Acre.	Quantity of Dressed Grain per Imp. Acre.	Weight per Bushel.	Weight of Straw per 1-8th Imp. Acre.	Weight of Light Grain per 1-8th Imp. Ac.	Weight of Chaff per 1-8th Imp. Ac.	Quantity of Dressed Grain per Imp. Acre.	Weight of Straw per Imp. Acre.	Weight of Light Grain per Imp. Acre.	Weight of Chaff per Imp. Acre.
			s. d		L. s. d	bush. lbs.	lbs.	cwt. qr. lbs.	lbs.	lbs.	qr. bu. lbs.	cwt. qr. lbs.	lbs.	lbs.
1.	Sulphate of Ammonia, ...	28 lbs.	5 $2\frac{1}{2}$	2 cwt.	2 1 8	7 $11\frac{3}{4}$	$41\frac{7}{16}$	5 1 2	$2\frac{1}{8}$	$14\frac{3}{4}$	7 2 11	42 0 16	20	118
2.	Nitrate of Soda. .	21 lbs.	4 6	$1\frac{1}{2}$ cwt.	1 16 0	7 2	$41\frac{7}{16}$	4 1 24	$2\frac{3}{4}$	41	7 0 16	35 2 24	22	328
3.	Bone-dust and Sulphuric Acid, (dry.)	1 bushel.	4 6	8 bushels.	1 16 0	7 $8\frac{1}{4}$	$42\frac{2}{16}$	3 3 0	4	$11\frac{3}{4}$	7 1 24	3 0 0	32	94
4.	No application, . .	...	...	...	...	7 $3\frac{1}{2}$	$41\frac{1}{2}$	3 3 12	$2\frac{3}{4}$	$37\frac{1}{4}$	7 0 28	30 3 12	22	302
5.	Ashes of Shellings of Oats, . . .	5 bushels.	0 6	40 bushels.	0 4 0	7 $35\frac{1}{2}$	$42\frac{5}{16}$	4 1 3	$2\frac{1}{4}$	44	7 6 30	34 0 24	18	352
6.	Guano, ...	28 lbs.	3 6	2 cwt.	1 8 0	8 $4\frac{14}{16}$	$41\frac{9}{16}$	5 0 26	$4\frac{3}{4}$	$35\frac{3}{4}$	8 0 39	41 3 12	38	286

*** Field slopes to the east. Variety of Oats called " English Barley." Sown on the 17th April.

Periodic Observations.

No.	When applied.	First Observation, June 9.	Second Observation, June 17.	Third Observation, June 24.	Fourth Observation, July 1.	Fifth Observation, July 8.	Sixth Observation, July 15.	Seventh Observation, July 22.
1.	May 17.	No perceptible difference in any of the applications, all thick and healthy.	A perceptible improvement, getting thicker and of a deeper green than surrounding field.	Same remark as last week, a little better than No. 4.	Very luxuriant, equal and thick, nearly as good as No. 5, but not so dark a green.	Same remarks as last week.	Same remarks as on July 1, coming on ½ shot, stalks averaging about 2 feet long.	Same remarks as last week, except that the plots are all about half shot, and the difference of progress of shooting in any one is hardly now perceptible.
2.	May 17.	Do.	Tufts here and there looking better than No. 3.	No difference between this and No. 3.	This plot appears now rather stronger and thicker than No. 3.	Do.	Same remarks as July 1.	
3.	May 17.	Do.	Healthy, the same as rest of field.	The same remarks as last week.	Same remarks as formerly.	Do.	Do., apparently nearer shooting than Nos. 1, 4, 5, & 6, & same as 2, stalks of 2 & 3 from 1 f. to 15 in.	
4.	May 17.	Do.	Improvement scarcely perceptible.	Improvement now quite perceptible, but not quite so good as No. 1.	Very good, not quite equal to No. 1, but before No. 6, although of a lightish colour.	Do.	Same remark as July 1, and as above in regard to No. 1.	
5.	May 17.	Do.	Improvement quite marked, about equal to No. 1.	This plot is now decidedly a-head of No. 1.	Very luxuriant, equal and thick, of a deep green, manifestly the best of all in appearance.	Do., the young grasses looking very rich and much thicker than on No. 3.	Same remarks as on July 1 & 8, not so far advanced as No. 1 towards shooting, stalks about 2 feet long.	
6.	May 17.	Do.	A decided improvement, in colour deeper green than the others.	This plot has the superiority in appearance over the others, but it is a good deal tufted.	Still tufted, but very good, & of a beautiful deep green col.; not so good as Nos. 5, 4, or 1, as a crop, apparently.	Do.; same remarks as No. 5 in respect of the young grasses.	Do., Length of stalks the same as No. 5, where the oats are best.	

The above was cut down on the 16th September 1843, and built up into the stack-yard on the 26th of the same month in excellent condition, receiving no injury from rain, there being only a few slight showers during the time it was in stock.

Additional Observations.

June 28.

1, 2, and 6. Equal—darker than any of the others.
3. Rather better than No. 4.
4 and 5. Equal—good dark green—thick crop.

July 24.

1. Broad leaved—dark coloured—very luxuriant—half-shot. Rye-grass and clover very close and well advanced.

2. Thick—equal—dark—half-shot. Rye-grass and clover improved, but not so good as last.

3. Very strong—light in colour—and earlier.

5. Good and healthy, but not equal to last.

4. Similar to last—half-shot.

6. Very rich ear—half-shot—broad-leaved—strong stalk. Good rye-grass] and clover.

September 21.

Crop all cut and stacked in good order.

December 7.

The crop thrashed.

Farm, HAUGHS OF ASHOGLE, Parish of TURRIFF; Tenant, Mr JAMIESON.

Table of Results of Experiments on Hay.—*Crop* 1843.

No	Manures.	Quantity per 1 8th Imp Acre.	Cost per 1 8th Imp Acre	Quantity per Imp Acre.	Cost per Imp Acre	Green Weight per 1 8th Imp Acre	Dry Weight per 1 8th Imp Acre	Green Weight per Imp Acre, in Imp Stones	Dry Weight per Imp Acre, in Imp Stones	Increase per Imp Acre of Dry Hay in Imp Stones
			s d		£ s d	sts lbs	sts lbs	sts lbs	sts lbs	sts lbs
1.	Sulph of Ammon.	28 lbs	5 2½	2 cwt.	2 1 8	124 1	40 0	992 8	320 0	112 0
2.	Nitrate of Soda, .	21 lbs.	4 6	1½ cwt.	1 16 0	106 8	37 6	852 8	299 6	91 6
3.	Bone-dust and Sul. Acid, (dry)	1 bu.	4 6	8 bu.	1 16 0	96 4	31 2	770 4	248 0	40 0
4.	Gypsum, ...	28 lbs.	0 11	2 cwt.	0 7 4	82 7	26 10	660 0	213 10	5 10
5.	No application, .	–	–	–	–	84 7	36 0	676 0	208 0	
6.	Ashes of Shellings of Oats,	5 bu.	0 6	40 bu.	0 4 0	87 6	29 6	699 6	235 6	27 6
7.	Guano, ...	28 lbs.	3 6	2 cwt.	1 8 0	112 0	38 0	896 0	304 0	96 0
8.	Neutraliz. Urine,	280 gls.	2 4	2240 gl.	0 18 8	102 9	35 6	821 2	283 6	75 6

*** Field slopes to west. Perennial rye-grass, red and white clover.

The Manures were applied on the 16th May.
The red and white clover flowered simultaneously, (?) 6th July.
The Rye-grass flowered uniformly on 9th July.
The crop was made into seed hay, cut, and weighed 24th July, weighed dry, 26th August.

In consequence of the very dry weather, there was very little second crop, and no perceptible difference on any of the applications.

First Observation—June 27.

1. Rye-grass dark green—strong and luxuriant—the best on the field. Clover dark green, and also the best.
2. Equally dark in colour, but not so strong.—Rye-grass not so luxuriant.
3. Rather better than No. 5.
4. No apparent difference from No. 5.
5. Light crop, and colour light—fair mixture of rye-grass and clover—making little progress.
6. Similar to last.
7. Darker colour—thicker—advancing.
8. Nearly as good as No. 7—dark.

Second Observation—July 20.

1. Rye-grass strong, and clover thick, and advancing more than any on the field.
2. Scarcely so strong as No. 1, but dark in colour, and advancing.
3. Little difference from No. 5.
4. Similar to No. 5—little progress.
5. Seed nearly ripe—light colour.
6. Similar to No. 5.
7. Strong, thick, and growing.
8. Nearly as dark, but not so thick as No. 7.

Farm, STONEWELL, Parish of GAMERIE; Tenant, Mr JAMES STRACHAN.

Table of Results of Experiments on Hay.—*Crop* 1843.

No	Manures	Quantity per 1 8th, Imp Acre	Cost per 1 8th Imp Ac	Quantity per Imp Acre	Cost per Imp Acre	Green Weight per 1 8th Imp Acre	Dry Weight per 1 8th Imp Acre	Green Weight per Imp Ac in Imp Stones	Dry Weight per Imp Acre	Increase per Imp Ac of Dry Hay.	Decrease per Imp Ac of Dry Hay.	Green Weight of Aftermath per Imp Acre
			s d		L s d	tones lbs	stones lbs	stones lbs	stones lbs	tones lbs	tones lbs	stones lbs
1.	Sulphate of Ammonia, ...	28 lbs.	5 2½	2 cwt.	2 1 8	212 0	59 1	1696 0	472 8	38 4	..	518 0
2.	Nitrate of Soda, .	21 lbs.	4 6	1½ cwt	1 16 0	216 0	57 7	1728 0	460 0	25 10	..	640 0
3.	Bone dust and Sulphuric Acid, (dry)	1 bushel	4 6	8 bushels	1 16 0	196 0	51 1	1568 0	408 8	..	25 10	624 0
4.	Gypsum, . . .	28 lbs.	0 11	2 cwt.	0 7 4	212 0	54 7	1696 0	436 0	1 10	..	608 0
5.	No Application, .	..	..	..	..	209 7	54 4	1676 0	434 4	..	..	596 0
6.	Ashes of Shellings of Oats, ...	5 bushels	0 6	40 bushels	0 4 0	197 7	52 8	1580 0	420 8	..	13 10	608 0
7.	Guano, ...	28 lbs.	3 6	2 cwt.	1 8 0	197 6	52 8	1579 6	420 8	..	13 10	257 2

Manures applied on May 16.

*** Field slopes to the west. Rye grass, red and white clover.

Periodic Observations.

Observation—May 24.

1, 2. Begin to shew a greener tint. | 3, 4, 5, 6, 7. No effect yet apparent.

Observation—June 5.

1, 2. Improving much.
3. Not so good as 1 and 2, but better than 4, 5, 6.
4, 5, 6. Little apparent effect.
7. Advancing.

Observation—June 8.

1, 2. Considerably improved—dark green.
3. Thicker.
4, 5, 6. Equal—all advancing slowly.
7. Improving.

Observation—June 15.

1, 2. Beginning to lodge when wet.
3. Continuing to advance.
4, 5, 6. Equal—good mixture of rye-grass and clover.
7. Much improved.

Observation—June 22.

1. Best of all—lodged when dry.
2. Slightly inferior to last.
3. Good.
4. Nearly as good as No. 3.
5, 6. Similar to No. 4.
7. Very much improved in colour and luxuriance.

Observation—June 30.

Average Length of Rye-Grass.	Average Length of Clover.
1. Thirty-three inches.	1. Twenty-four inches.
2. Thirty-three inches.	2. Twenty-four inches.
3. Thirty inches.	3. Nineteen inches.
4. Twenty-nine inches.	4. Twenty inches.
5. Twenty-nine inches.	5. Twenty inches.
6. Thirty-one and a-half inches.	6. Twenty-two inches.
7. Thirty-two inches.	7. Twenty-two inches.

1. Much lodged—colour dark. Rye-grass and clover strong—appears later in flowering than the others.

2. Next best—darker green, lodged, thick; but rye-grass not so strong as last. Clover very rich.

3. Not nearly so heavy as last, but better than next—three plots light in colour. Rye-grass thick and strong—partly lodged.

4, 5, 6. Alike, with equal mixture of rye-grass and clover. The sole not close, on account of the stiffness of the soil.

7. Third best—not so dark in colour as the two first, but thick. The rye-grass and clover both equally improved. Some spots without any red clover, which must affect the weight; nevertheless, the crop appears much benefited, and nearly equal to No. 2.

Observation—August 18.

Plot No. 3 was inadvertently not cut so close to the ground as the rest, which will slightly affect the weight. The aftermath was best on this plot. The plants of red clover were rather deficient on plots 6 and 7, particularly the last. The hay was made after the English method, and in good weather.

Observation—October 4.

Aftermath looking well generally. Clover deficient in No. 7. The plots appear to possess merit in the following order:—*First*, No. 3—*Second*, No. 2—*Third*, No. 1.—*Fourth*, Nos. 5 and 6, equal—*Fifth*, No. 7.

The grass was cut first time on 12th July—weighed dry on 18th August—and aftermath cut 6th October.

Dates of Flowering.—Red Clover on July 12—Rye-Grass on July 14—White Clover on July 20. Little difference could be seen in the earliness between them.

Farm, ROTHIE-BRISBANE.

TABLE OF RESULTS OF EXPERIMENTS ON HAY.—*Crop* 1843.

No.	Manures.	Quant. per 1 8th Imp. Ac.	Cost per 1-8th Imp. Ac.	Quant. per Imp. Ac.	Cost per Imp. Acre.	Green weight per 1 8th Imp. Ac.	Dry weight per 1-8th Imp. Ac.	Green weight per Imp. Ac.	Dry weight per Imp. Ac.	First Observation, June 8.	Second Observation, June 28.	Remarks.
			s. d.		£ s. d.	stones lb	stones. lb	stones. lb	tons. lb			
1.	Sul. of Ammonia,	28 lbs.	5 2½	2 cwt.	2 1 8	204 0	59 6	1632 0	475 6	Rye-grass, 12 inches. Clover, . 8 Luxuriant, dark coloured, thick.	Improving rapidly, best on the field.	No. 1. was on a ridge alongside a plantation, the shelter of which, perhaps, afforded to it some advantage.
2.	Guano, . . .	28 lbs.	3 6	2 cwt.	1 8 0	166 0	50 0	1328 0	400 0	Rye-grass, 10 inches. Clover, . 10 Much improved, not so dark nor so thick.	Very luxuriant, not quite so thick as last.	
3.	No application,	..	..	..	..	164 0	48 3	1312 0	385 10	Rye-grass, 8 inches. Clover, . 6 Uniform, with the whole field well supplied with clover and rye-grass, very backward from the cold weather.	Little difference.	
4.	Ashes of Shellings of Oats,	38½ lbs.	..	40 bush.	..	176 0	48 4½	1408 0	386 8	Somewhat similar.	Similar.	
5.	Nitrate of Soda,	21 lbs.	4 6	1½ cwt.	1 16 0	148 0	44 0	1184 0	352 0	Rye-grass, 11 inches. Clover, . 10 Colour dark.	Very thick, dark green, clover good.	This ridge was most remote from the shelter.
6.	Gypsum, . .	28 lbs.	0 11	2 cwt.	0 7 4	..	35 13½	..	287 10	Similar to No. 4.	Little improved.	These three plots (6, 7, and 8,) were on another part of the field, and are only comparable one with the other. There was a deficiency of clover pl nts in that part of the field, although the rye-grass was clean and good.
7.	No application,	..	..	..	..	..	35 2	..	281 2	Do.	No difference from No. 6.	
8.	Bone-dust and Sulph. Acid,	1 bush.	4 6	8 bush.	1 16 0	..	33 8	..	268 8	Some improvement.	Little difference from last.	

Field slopes to the east. Rye-grass, Red and White Clover.

Farm, MILL OF LAITHERS, Parish of TURRIFF; Tenant, Mr JAMES MURRAY.

TABLE OF RESULTS OF EXPERIMENTS ON OATS AFTER LEA.—*Crop* 1843.

No.	Manures.	Quantity per 1-8th Imp. Acre.	Cost per 1-8th Imp. Acre.	Rate per Imp. Acre.	Cost per Imp. Acre.	Quantity of Dressed Grain per 1-8th Imp. Acre.	Weight per Bushel.	Weight of Straw per 1-8th Imp. Acre.	Weight of Light Grain per 1-8th Imp. Ac.	Weight of Chaff per 1-8th Imp. Ac.	Quantity of Dressed Grain per Imp. Acre.	Weight of Straw per Imp. Acre.	Weight of Light Grain per Imp. Acre.	Weight of Chaff per Imp. Acre.
			s. d.		L. s. d.	bush. lbs.	lbs.	cwt. qr. lbs.	lbs.	lbs.	qrs. bu. lbs.	cwt. qrs. lbs.	lbs.	lbs.
1.	Sulphate of Ammonia, . .	28 lbs.	5 2½	2 cwt.	2 1 8	7 0¼	41	3 1 27	6¼	51	7 0 2	27 3 20	50	412
2.	Nitrate of Soda,	21 lbs.	4 6	1½ cwt.	1 16 0	5 15	41¼	3 0 10	9	74	5 2 37½	24 2 24	72	592
3.	Bone-dust and Sulph. Acid,	1 bush.	4 6	8 bush.	1 16 0	5 7¼	42	2 1 12	5	24½	5 1 16	18 3 12	40	196
4.	No application,	...	...	...	...	5 10¾	42	2 1 26	4½	34	5 2 2	19 3 12	36	272
5.	Guano, . . .	28 lbs.	3 6	2 cwt.	1 8 0	5 *34¾	42	2 3 13	3½	45	5 6 26	22 3 20	28	360
6.	Neutralized Urine, . .	280 gals.	2 4	2240 gals.	0 18 8	6 2	41¼	3 0 6½	2¾	38	6 0 16	24 1 24	22	304

*** Field slopes to the south-west.

Periodic Observations.

1, 2, 3, and 5, were applied on 15th May, and No 6, on the 29th of the same month. The produce was thrashed and weighed 22d January 1844. The oats were of the variety called "Sandy."

First Observation—May 24.

No perceptible difference on any of the experiments.

Second Observation—June 28.

1. Darker than the rest, and advancing most.
2. Do. do.
3. Next in order—plants strong—leaves broad.
4, 5, 6. Much alike—good healthy braird.

The cold weather hitherto has kept the crop back very much. It is only within the last few days that any difference was perceptible on any of the plots. The braird appears very uniform and equally thick over all the experimental plots, and the rest of the field.

Third Observation—July 22.

1. Dark strong colour—broad leaved—head rich—two-third shot—1 ft. 9 in. long.
2. Darkest—thick—half-shot—very luxuriant—2 ft.
3. Earliest—light in colour—nearly fully shot—1½ ft.
4. Not so early as last—darker—1 ft. 8 inches long.
5. Very luxuriant—half shot—2 ft. long.
6. Scarcely so good as last—much improved—half shot—nearly as high as last.

Fourth Observation—No Date.

1. Dark-coloured straw—rather late.
2. There are a great number of abortive flowers on this plot—not perceived on the others.
3. Well-coloured—earliest—small straw.
4. Not so uniformly ripened as last.
5, 6. Equal—pretty thick—not well coloured.

Observation on the straw.

At the time of thrashing, (Jan. 22, 1844,) the straw was carefully examined, and the produce of the different plots appeared to possess merit in the following order:—

First. No. 4—Finest colour—white and red.
Second. .. 3—Very thin straw.
Third. .. 5—Soft to the feel—rather darker and broader—no red colour.
Fourth. .. 6—Softer than the last, but pretty much the same in colour.
Fifth. .. 1—Darker—broadest leaves—strongest.
Sixth. .. 2—Very dark yellow—soft—not so strong and broad as last.

Farm, ROTHIE-BRISBANE.

Table of Results of Experiments on Oats after Lea.—*Crop* 1843.

No.	Manures.	Quantity per 1-8th Imp. Acre.	Cost per Imp. Acre.	Rate per Imp Acre.	Cost per Imp Acre	Quantity of Dressed Grain per 1-8th Imp Acre.	Weight per Bushel.	Weight of Straw per 1-8th Imp Acre.	Weight of Light Grain per 1-8th Imp Ac	Weight of Chaff per 1-8th Imp Acre	Quantity of Dressed Grain per Imp Acre	Weight of Straw per Imp. Acre	Weight of Light Grain per Imp Acre	Weight of Chaff per Imp Acre.	Remarks.
			s d		L s d	bus lbs	lbs	cwt. qr lbs	lbs	lbs	qrs bus lb	cwt qrs lbs	lbs	lbs	
1.	Sulphate of Ammonia,	28 lbs.	5 2	2 cwt.	2 1 8	10 8⅓	41¼	7 1 16	16½	17	10 1 26¾	59 0 16	132	136	Very dark, strong, broad leaved, thick, and lodged.
2.	No Application,	—	—	—	—	6 31	43	5 0 1½	4½	80	6 5 33	40 0 12	36	640	Lighter coloured leaves, thinner, and not so rich an ear.
3.	Guano,	42 lbs.	5 3	3 cwt.	2 2 0	8 39	43	6 1 1	7½	49	8 7 11	50 0 8	60	392	Thickest crop, very uniform in size, rich ear, a little lodged.

*** Field slopes to the south.

The above Manures were applied on 18th May. The Oats were of the variety called "Scot's Barley." Results weighed 28th January 1844.

The course followed in this case happening to be a seven years' rotation, the lea of which is succeeded by two consecutive grain crops, attention was paid to ascertain whether any difference would appear on the oat crop of 1844. In the end of June, it seemed that Plot No. 1 was not equal to No. 3; but, by the end of July, no difference could be detected by the eye.

Farm, LOWER COTBURN, Parish of TURRIFF; Tenant, Mr WILLIAM MORRISON.

Table of Results of Experiments on Oats after Lea.—*Crop* 1843.

No.	Manures.	Quantity per 1-8th Imp. Acre.	Cost per 1-8th Imp. Acre.	Rate per Imp. Acre.	Cost per Imp. Acre.	Quantity of Dressed Grain, per 1-8th Imp. Acre.	Weight per Bushel.	Weight of Straw, per 1-8th Imp. Acre.	Weight of Light Grain per 1-8th Imp. Ac.	Weight of Chaff per 1-8th Imp. Ac.	Quantity of Dressed Grain per Imp. Acre.	Weight of Straw per Imp. Acre.	Weight of Light Grain per Imp. Acre.	Weight of Chaff per Imp. Acre.
			s. d.		£ s. d.	bus. lbs.	lbs	cwt. qrs lbs	lbs.	lbs.	qrs bu lbs	cwt. qrs. lbs	lbs	lbs.
1.	Sulphate of Ammonia, . .	28 lbs.	5 2½	2 cwt.	2 1 8	7 2½	42	4 1 3½	5	42	7 0 20	34 1 0	40	336
2.	Nitrate of Soda,	21 lbs.	4 6	1½ cwt.	1 16 0	6 0	42½	3 2 25	5½	40	6 0 0	29 3 4	44	320
3.	Bone-dust and Sul. Acid, dry,	1 bush.	4 6	8 bush.	1 16 0	4 34½	42¾	2 3 1	4	24	4 6 19½	22 0 8	32	192
4.	No Application,		--	--	--	4 16	42½	2 1 26	3	37½	4 3 0½	19 3 12	24	300
5.	Ashes of Shellings of Oats,	5 bush.	0 6	40 bush.	0 4 0	4 22	42¼	2 2 8	3	21½	4 4 7	20 2 8	24	172
6.	Guano, . . .	28 lbs.	3 6	2 cwt.	1 8 0	6 22½	41½	3 3 17	6¼	28	6 4 14	31 0 24	50	224

Farm, LOWER COTBURN.

PERIODIC OBSERVATIONS AND REMARKS.

First Observation—July 19.

1. In advance of the others—dark strong culms and broad leaves—rather thick.
2. Improving, not so dark, and rather earlier than last.
3. Not so dark nor heavy as last, but apparently better than No. 4—culms rather longer.
4. Farthest advanced and shortest, but thick enough. The crop on this ridge is very uniform with the rest of the field.
5. Similar to the last.
6. Strong, dark, thick, broad leaved—much better than last.

Second Observation.—Sept. 1.

1. Decidedly heaviest, strong straw—scarcely so ripe as the other experiments.
2. Next best—not so strong straw.
3. Good—rather better than No. 4.
4. Good equal crop.
5. Similar to last.
6. Resembling No. 2—rich head.

The ground appears well selected, soil 7 inches deep. The weather was remarkably fine, quiet, and much sunshine. The crop got no rain from the time it was cut to being built in the stack. In cutting the crop it was observed that the straw after No. 6 was hardest, tougher than any of the others; also that the crop after No. 5 was rather unequally ripened.

Observations on the Straw.

1. Straw strongest, long, and darker than No. 2.
2. Straw stronger than Nos. 4 and 5—light colour, but no redness—soft and tough.
3. Finest—white and red colour—considered better than any of the other.

4 & 5. Equal, but scarcely so white as No. 3.

6. Darkest yellow straw—not so strong as No. 1—no redness.

The quantity of chaff from each experiment will give some idea of the freeness of the grain and chaff to come from the head of corn. Much chaff was left on the No. 6 straw, and it was tough to thrash. The utmost exactness was used in applying the manures, cutting the crop, and thrashing the grain. Each bushel of grain was weighed, to give the exact weight of rate per bushel. The samples shew considerable difference in colour as well as weight. The greater weight had the best colour. Nos. 3, 4, 5, 6 were first ripe, cut September 9, and carted on the 16th. Nos. 1 and 2 cut on the 12th September, and carted on the 19th.

EFFECT ON THE SUCCEEDING CROP.—*Crop* 1844.

The rotation at Lower Cotburn being a seven-course one, two grain crops being taken after lea, the plots were marked and the effect on the crop of 1844 examined. On two of the plots, viz., guano and bone dust, with sulphuric acid, there was an increase of fully one quarter of oats per acre each. No perceptible difference could be detected between the other plots and that to which nothing was applied.

Farm, MILL OF LAITHERS.

Results of Experiments on Hay.—*Crop* 1843.

No	Manures.	Quantity per 1-8th Imp Acre.	Cost per 1-8th Imp Acre.	Quantity per Imp. Acre	Cost per Imp. Acre.	Green Weight per 1-8th Imp. Ac	Dry Weight per 1-8th Imp. Ac	Green Weight per Imp Acre in Imp Stones.	Dry Weight per Imp Ac in Imp Stones	Increase per Sul. A of Dry Hay in Imp Stones
			s d		L. s d	sts lbs	sts lbs	sts lbs	sts lbs	sts lbs
1.	Sulphate of Ammonia, ...	28 lbs.	5 2½	2 ct	2 1 8	173 9	54 13	1389 2	439 6	85 10
2.	Nitrate of Soda,	21 lbs.	4 6	1½ ct.	1 16 0	163 1	51 0	1304 8	408 0	54 4
3.	Bone-dust and Sulphuric Acid, (dry,)	1 bus.	4 6	8 bu.	1 16 0	140 0	45 6	1120 0	363 6	9 10
4.	Gypsum, . . .	28 lbs.	0 11	2 ct.	0 7 4	144 0	46 10	1152 0	373 10	20 0
5.	No Application,	—	—	—	—	140 0	44 3	1120 0	353 10	
6.	Ashes of Shellings of Oats,	5 bus.	0 6	40 bu.	0 4 0	140 0	44 10	1120 0	357 10	4 0
7.	Guano, ...	28 lbs.	3 6	2 ct.	1 8 0	161 2	50 12	1289 2	406 12	53 2
8.	Neutralized Urine,	280 gal.	2 4	2240 gl.	0 18 8	165 1	53 6	1320 8	427 6	73 10

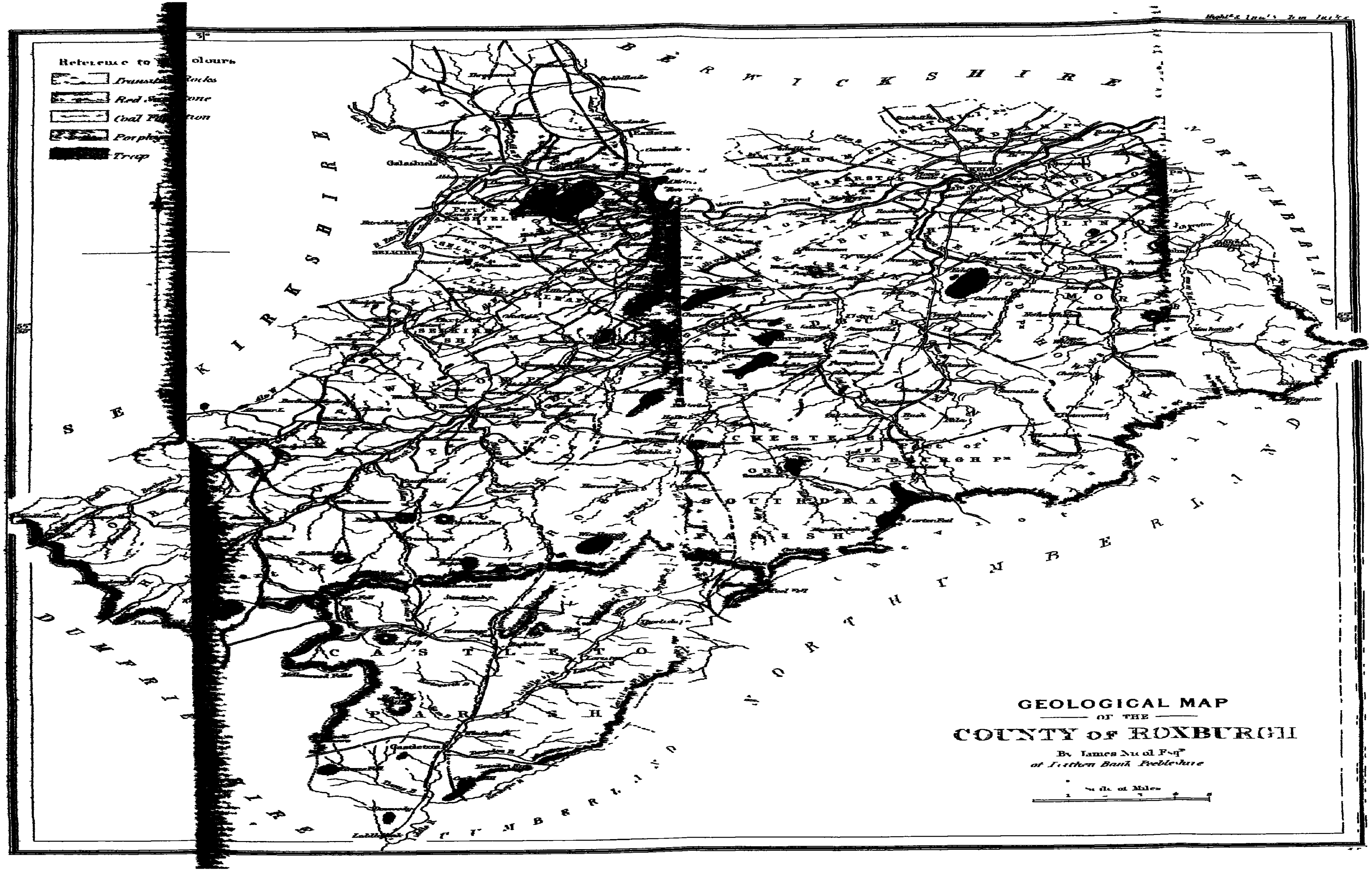
*** Field slopes to the north. Rye-grass, red and white clover.

Periodic Observations and Remarks.

The Manures were applied from the 15th to 18th of May. Very cold rainy weather followed till the middle of July. The Rye-grass and Clover appeared to flower at same time, viz., July 9th. The crop was cut 21st July, and weighed dry 19th August. The hay was carefully prepared after the English method.

First Observation—June 28th.

No	Length of Rye-Grass.	Length of Red Clover.	Remarks.
1.	29½ inches.	20 inches.	Dark green, strong. Rye-grass thick—much lodged.
2.	29 inches.	26 inches.	Dark green, thick, clover very luxuriant. Rye-grass not so strong—culm as last.
3.	28 inches.	20 inches.	Little difference from No. 5.
4.	24 inches.	20 inches.	No difference—rather backward.
5.	27 inches.	17 inches.	Good mixture of rye-grass and clover—clean—uniform over the field—advancing slowly.
6.	28 inches.	17 inches.	Much improved and very luxuriant—thick, dark green.
7.	29 inches.	20 inches.	Scarcely so luxuriant as No. 6. Clover and rye-grass strong.
8.	29 inches.	20 inches.	


GEOLOGICAL MAP
OF THE
COUNTY OF ROXBURGH
By James Nicol Esqr
of Traquair Bank Peebleshire
Scale of Miles
Reference to the Colours
Transition Rocks
Red Sandstone
Coal Formation
Porphyry
Trap
BERWICKSHIRE
NORTHUMBERLAND
SELKIRKSHIRE
DUMFRIESSHIRE
CUMBERLAND
CASTLETON PARISH
SOUTHDEAN PARISH
Galashiels
Selkirk
Castleton

Second Observation—July 21.

1. Rye-grass very strong, and much lodged. Red clover particularly fine, dark, and broad leaved.
2. Abundant crop—much lodged, but not so good as last.
3. A little better than No. 5—considerably improved since last observation.
4. Inferior to neither of last.
5, and 6. Similar to No. 4.
7. Considerably improved—sole thick and close—lodged.
8. Clover very luxuriant, more so than the rye-grass—lodged.

ON THE GEOLOGY OF ROXBURGHSHIRE.

By James Nicol, Esq., Leithen Bank, Peeblesshire.

[Premium, Fifty Sovereigns.]

There is probably no county in Scotland which possesses a more truly general and national interest than Roxburghshire. Bordering immediately on England for sixty miles, or about two-thirds of the whole distance uniting the rival kingdoms, and unprotected by those rivers which divided them in other quarters, it was always the first to feel the evil consequences of their dissentions, many of which were decided on its hills or plains; and its inhabitants were so inured to war, that it was regarded only as "the Borderer's game." With it, too, is connected much of the traditional poetry of the country, from the "Hunting of the Cheviot," and the Rhymer's Prophecies, learned beneath the Eildon Tree, to the "Lay of the Last Minstrel" and the "Tale of Flodden Field." But the history and traditions of a people are always influenced by the character of the land in which they dwell, and in the latter the philosopher can often trace the hidden causes on which the peculiarities of the former depend. Hence, even to the historian and the lover of traditionary lore, the physical features of Roxburghshire cannot be uninteresting, as explaining many important events connected with the fortunes of the nation, and illustrating numerous local allusions in its poetry. We, however, hope to shew that, even in themselves, and independent of all extrinsic circumstances, the physical features and geological relations of this county are well worthy of consideration.

Roxburghshire is forty-four miles in its greatest length from south-west to north-east, and twenty-eight miles broad in the transverse direction. Exclusive of the northern part of Melrose parish, it forms an irregular rhomboid, of which the south-east side, from Liddlebank to Arkhope Cairn, measures thirty-eight miles; the north, from the latter point to near Stitchill, seventeen miles; the north-west side, from this place to Mood-

law Loch, thirty-five miles; and the remaining, or south-west side, from the last of these localities to the first twenty-one miles. This principal mass of the county, therefore, contains about 700 square miles, and when the part cut off on the north is added, its whole extent will amount nearly to that usually given, or 725 square miles.* It comprises the whole of the ancient divisions of Teviotdale and Liddlesdale, with a part also of Lauderdale. The largest and most important portion belongs to the first division, which includes not merely tho basin of the river whence it is named, but also the banks of the Tweed. This part of the county belongs to the great southern valley of Scotland, lying between the transition hills or Southern Highlands on the north, and the Cheviot Hills on the south. The river Teviot, the true continuation of the lower Tweed, marks the general direction both of the hills and valleys in this part of the island, almost never deviating a mile, either to the right or left, from a straight line drawn from its source to its mouth in the sea at Berwick, a distance of fifty-five miles. The principal mountain ranges lie therefore rather on the sides than in the centre of this district, and the hills, some of them of considerable elevation, which appear in the latter, are detached summits, originating in causes more recent than those which have determined the general structure of the country. This district, taken as a whole, may be viewed as a wide valley divided into several smaller ones by parallel ridges. Hence, in crossing it from north to south, the road forms a continual series of ascents and descents, which can only be avoided by proceeding from west to east, along the courses of the rivers. This character is, however, more peculiar to the portion north of the Teviot than to that on the south, where the influence of the Cheviot Hills begins to predominate. Hence, whilst in the former, the streams, as the Borthwick, the Ale, St Boswell's Burn, and Bowden Burn, run all north-east, parallel to the Teviot, those in the latter take a far more northerly course. Of this the Allen, Slitrig, Rule, Jed, and Oxnam Waters, with the upper part of the Kale and Beaumont, are good proofs, including, as they do, all the principal streams in this district. The former, or north-easterly direction, is that peculiar to the greywacke, as will appear from a glance at the map; whilst the other is appropriated to the porphyry, and is more decidedly expressed wherever this rock prevails. The upper part of the Jed has a very anomalous course, but is not improbably connected with the causes which have limited the extent of the porphyry westward, and in part also with the trap of Southdean Hill.

* Of this extent less than 100 square miles belong to the basin of the Solway, and consequently upwards of 600 to that of the Tweed. The whole basin of this river amounts to about 1800 square miles, of which more than a-third is contained in this county.

The curious bend in the Kale and Beaumont, on the line from Morebattle to Yetholm, in like manner indicates a point of elevation in the high land on the north, between it and the Tweed. The small portion of Lauderdale resembles in general features the greywacke districts to the south-west, except that the rivers run in a south-east direction, transverse to the primary one of this formation.

Liddlesdale, the other division of the county, also belongs to the great southern valley, though not included in the basin of the Tweed, but in that of the Solway. This district is distinguished by many peculiarities both in the manners of its inhabitants and in natural features. Round the sources of the Hermitage and Liddle rise numerous lofty mountains, forming ridges with the general north-eastern direction. Farther west, and on the borders of England, the hills are lower and less abrupt, the valleys more extensive and level. It is mostly a pastoral district, being in general covered by a rank luxuriant vegetation of coarse grass and carices, partly the result, partly the cause, of its moist and variable climate.* The courses of its rivers have in general been determined by the north-east lines of elevation, and consequently run parallel to the Teviot though in an opposite direction.

Geologically considered, Roxburghshire may be divided into five districts, each characterised by peculiar rock formations. These are the Liddlesdale sandstone district in the south-west; the greywacke district, comprising the whole north-west and part of the centre of the county; the Teviotdale or red sandstone district, or the lower part of the valley of that river and its tributaries, with the middle course of the Tweed; the Kelso coal formation found in the low country round that town; and the Cheviot porphyry district in the south-east angle of the county; to which, perhaps, a sixth might be added, of the districts occupied principally or exclusively by trap rocks. The formations of which it consists almost correspond to those, and may be arranged as follows, local names, for reasons that will subsequently appear, being assigned to some of them:—

Stratified Formations.	*Igneous Formations.*
TRANSITION.	
Greywacke and clayslate.	Felspar porphyry.
SECONDARY.	
Teviotdale (old) red sandstone.	Cheviot porphyry.
Coal formation.	Eildon porphyry.
(*a*) Kelso sandstones.	
(*b*) Liddlesdale sandstones.	Trap rocks.

* No fact in meteorological science is better established than the influence of the soil and vegetation of a country on the amount of aqueous deposition from the atmosphere. Liddlesdale is covered with a thick mass of herbage, which retains the moisture like a sponge, is slowly warmed by the sun during the day, and radiates

In a mineralogical point of view these rocks are not very interesting, being rather uniform both in aspect and composition, and containing no remarkable minerals, and very few organic remains. In their geological relations, however, more diversity prevails, since they are united in a very complicated manner, and exhibit many phenomena possessing a high and even a classic interest in the history of geology. It is sufficient to refer to the junction of the red sandstone and the greywacke on the Jed, first described by Hutton, which even yet remains one of the most instructive examples of that class of phenomena. We shall now proceed to give an account of the formations individually, in the order in which they are arranged above, commencing with the oldest stratified deposits and concluding with the igneous rocks. Their mutual relations, with some considerations of a more theoretical nature, will follow; after which we shall notice the more recent alluvial deposits, and the causes to which these owe their origin, and which have produced the last great changes on the physical features of the county.*

The *Greywacke* is the most extensive formation in this county, of which it probably occupies about a third, or 290 square miles. It constitutes the whole western side of the county from Melrose parish on the north to Hawick, Cavers, and the sources of the Hermitage in Castleton on the south. This portion forms the southern declivity of the great mass of this rock, which occupies the whole of Selkirkshire and much of the neighbouring counties, forming the central nucleus of the Southern Highlands. Nearly parallel to this is another range, extending from Ernton Hill in Liddlesdale to the borders of Crailing parish beyond Oxnam. These are connected by a branch in Hobkirk parish near the

much heat during the night. Hence it is constantly covered by a cold column of air, which, by a well-known law, attracts and condenses the vapour contained in the surrounding atmosphere. Were the ground properly drained and cultivated, one great cause of the frequent rains would be removed, and we should hear fewer complaints of the dampness and uncertainty of the climate.

* It may not, perhaps, be out of place here to make a few remarks on the map attached to this essay, taken from the one surveyed by N. Tennant, and engraved by W. and A. K. Johnston, Edinburgh, 1840. It is the latest and best we could procure, but still is deficient in many important respects. The rivers, roads, and houses, in the more cultivated parts of the county are laid down with tolerable accuracy, but the same praise cannot be given to it in the wilder districts. The hills and other inequalities of the ground are laid down apparently without any regard to the natural features of the country, and are seldom to be depended on. For instance, Southdean Hill, a very remarkable one in many respects, is wholly omitted, and a very inaccurate representation is given of Ruberslaw, and of those on the borders of Liddlesdale and in other places. Many small rivulets, often marking the limits of a formation, or other important geological facts, are omitted, so that, even on the ground itself it is impossible to lay them down accurately. Nothing is a greater assistance to the geologist than correct maps, without which it is almost impossible to form general ideas of the physical structure of a country, and the relations of this to its geology.

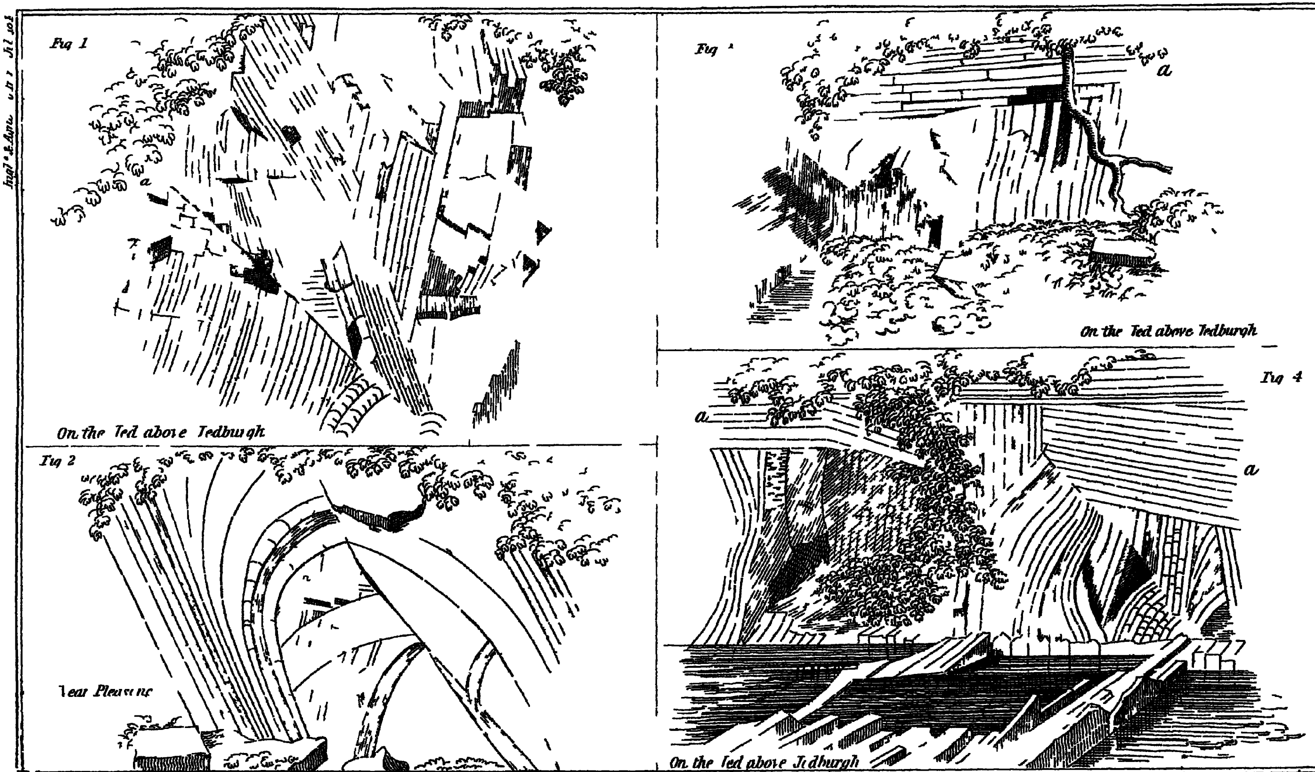


Fig 1
a
On the Jed above Jedburgh
Fig 2
Near Pleasance
Fig
a
On the Jed above Jedburgh
Fig 4
a
a
On the Jed above Jedburgh

PLATE I

sources of the Rule. Some detached portions are found in the course of the Jed at Kersheugh and Jedburgh; but for these and the more exact limits of the principal mass we must refer to the map.

This formation in this county consists almost entirely of *greywacke* and *clayslate*. The former is principally composed of fragments of clayslate mixed with a considerable proportion of minute scales of mica and fine grains of quartz. The greywacke in this county, especially in the south, differs considerably from the same rock as seen in the northern parts of the transition mountains in Mid-Lothian and Peeblesshire. The whole materials are more finely comminuted, coarse conglomerates are far more rare, and the proportion of quartz much smaller here than in the latter district. As usually happens with the finer varieties of this rock, it is also disposed in thinner and more regular beds, and rarely presents those huge unshapely masses common on the north, in which marks of stratification can hardly be said to appear. Clayslate is also more frequently interstratified with the greywacke, and transitions from the one to the other are common, shewing that they are in many cases mere varieties of one rock. The usual colour of both is a light grey or blue, often inclining to brown. The clayslate, and more rarely the greywacke, has in many places a dark red or purple colour, and sometimes, as, for example, in the section above Jedburgh described by Hutton, they have a mottled aspect, the grey being clouded with brown or red. A greenish tinge, approaching to yellow, is also common in both rocks. Some varieties seem to have been produced by igneous action, as the red ferruginous greywacke found near the Eildon and Minto Hills. Where, however, this is intermixed with beds of the usual appearance, some original difference may be supposed. In Burnmouth Hill, near Oxnam, the greywacke is very much altered by the porphyry, being red, ironshot, and much hardened, broken, and confused. Some of the slate found near the trap at Rink, above Edgerton, is of a greenish-white colour, with a greasy feel like soapstone. This white slate is found in two places in thin layers, much cracked and broken, and sometimes slightly curved. The slate, in general, has the common blue or grey colour, but part of it is red. This is sometimes curiously striped with parallel bands of a darker colour, resembling a blade of grass with a strong vein in the centre. They much resemble the impression of some fossil, but more probably are the result of igneous action. The slate containing them is exceedingly fragile, and crumbles down with the smallest pressure. As these varieties are mixed with the common rock, they shew that some difference in the composition of this has originally existed, causing one part to be more affected by the trap than another.

No fossils have hitherto, so far as we are aware, been found in the greywacke of this county, and we have only observed some appearances of this kind in one place. This is in the west branch of Riccarton Burn, on the south side of Ernton Hill, in Liddlesdale. The rock here is a slaty greywacke, interstratified with clayslate, and is disposed in verticle beds with a direction to W. 20° S. In the greywacke are numerous black carbonaceous impressions, like the imperfect remains of plants common in the coal sandstones. We have no doubt that this is their true nature, though they are too indistinct and fragmentary to permit of complete certainty. They thus indicate an approach to the upper part of the transition series, which is also shewn by some other phenomena. Thus, in many places, the greywacke so much resembles the old red sandstone, that in hand specimens they can scarcely be distinguished. Remarkable examples of this may be found near the junction of the greywacke with the red sandstone on the Jed, above old Jedburgh, where some beds have completely the aspect of the latter rock. This is also the case in the burn on the north side of Ruberslaw, above Whitrigs, where some thin beds of the greywacke might easily be mistaken for sandstone, but are interstratified with undoubted clayslate. These facts, though interesting, do not furnish sufficient data for comparing the transition rocks of this county with those of England. They, however, shew the impropriety of classing them, as is often done, with the lower non-fossiliferous groups of that country.

The principal veins in these rocks consist of quartz and calcareous spar. The former is most abundant in the north, but far less so on the whole than the latter. This is usually white, but in some instances, as particularly in the burn near Hassendean, a beautiful red. Even in small hand specimens, proofs of more than one set of veins may be observed. In some cases they seem to have been cracks in the rock, probably produced by heat, and subsequently filled with calcareous or siliceous matter. In the dark red greywacke, near the Eildons, much red iron ore is contained, both mixed with the rock and in veins. It is found, but more rarely, in other parts of the formation, though here it seems the result of igneous action.

In this county we find many indications that the greywacke has undergone some powerful disturbing action at a very early period, probably prior to the deposition of any of the other strata or the eruption of the trap or porphyry rocks. The beds may frequently be observed broken, bent, and curiously contorted in places where no other rocks are visible, except the slate and greywacke. Instances of this may be seen at Hutton's section on the Jed, above Jedburgh, where the sides, and especially the bed of the river, exhibit many very intricate and confused groups

PLATE II.

Highl. & Agric. Soc. Trans. July 1843.

Fig. 5.

On the Jed above Fernihirst.

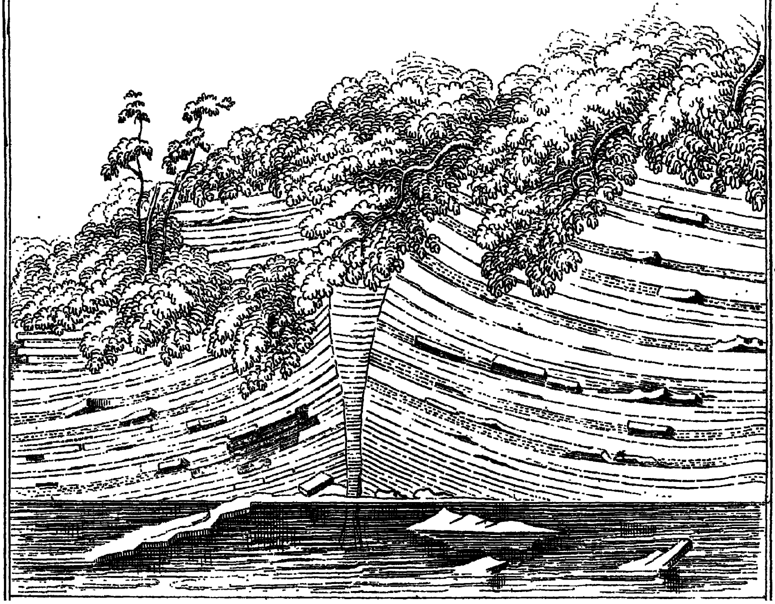
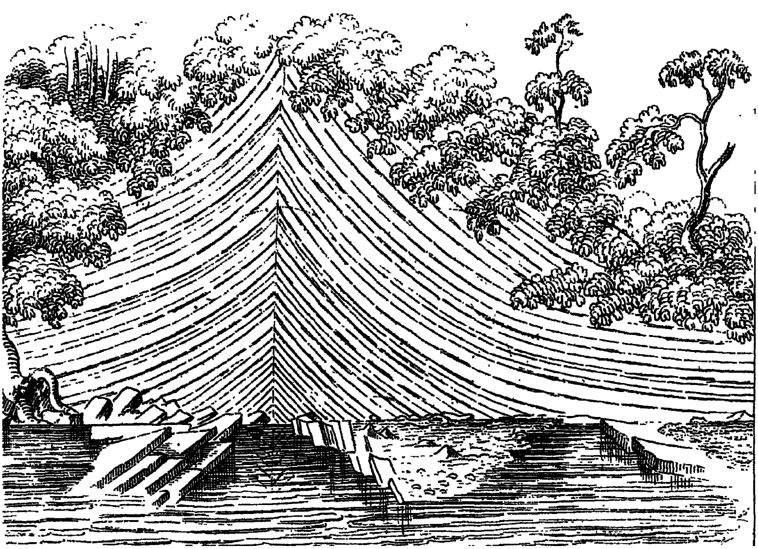


Fig. 6.

On the Jed above Fernihirst.



of strata.* Above old Jedburgh, at the junction with the red sandstone on the same river, is another curious example of this, the rocks, besides being bent and broken, appearing hardened and contracted by heat. At Weensland, below Hawick, near the Teviot, and above Pleasance, in Oxnam parish,† are similar instances, which indeed are common in almost every greywacke district. The surface of this rock is also often marked by very singular convolutions, resembling those on a piece of crumpled cloth. The surfaces are smooth, and the divisions, sinking into the solid stone, shew that they are the result of some change which has affected the whole rock, and not merely of a superficial action at the time when the beds were deposited. The strata so marked, and also those disturbed and broken, are usually accompanied with beds of fine slate, very often of a loose shivery texture, breaking into fragments, few of which exceed the size of a shilling; and where it is more compact, the slaty structure is often transverse to the stratification. The clayslate is then curiously marked and undulating on the surface next the greywacke, and often seems to ramify among its broken masses. These facts, and especially the general aspect of the sections mentioned, with many similar ones in other parts of the transition mountains, have led us to suspect that some of the clayslate beds have not, as is generally supposed, been deposited from water, but are of igneous origin, and have been injected in a fluid state amongst the greywacke strata. In many cases where the two rocks are firmly united in one specimen, the line of junction is very distinct, so that the one seems rather welded to the other than to pass into it. We are far from ascribing this origin to all the clayslate rocks, as, in regard to many of them, there are facts which appear irreconcilable with this supposition, but rather should propose it as a subject of future inquiry, whether there are not some of them to which it is applicable. Should this theory be well founded, it will account for many anomalous appearances, and explain some difficulties connected with the transition rocks, both of this county and of Scotland generally. We have never yet seen any adequate cause assigned for the general high inclinations and the singular convolutions by which these rocks are distinguished. These are evidently long anterior to the eruption of the Cheviot porphyry or the trap rocks, since these have spread over the red sandstones which rest on the upturned edges of the greywacke, and no other formation, generally considered as igneous, occurs in sufficient amount for this

* In Figs. 1, 3, 4, Plate I., portions of this section are represented; the greater proportion being the greywacke and slate, and the portion at *a* being the superior sandstone. At *a*, in Fig. 1, is a portion of the greywacke breccia, forming a kind of vein.

† See Fig. 2, Plate I.

purpose. The transition porphyries are wholly inconsiderable, and limited to a mere corner of the county, whilst the phenomenon to be explained is nearly universal.

We have already mentioned that this formation is in general very regularly stratified. The beds are thin, and their dip and direction usually very distinct. There is, however, little variety in these, especially the direction, which seldom varies above five or ten degrees from the magnetic east and west. The dip is more commonly to the south than north, and varies from 40° to 90°, the lower angles being more common than the higher; much more so than in the northern portions of the transition mountains where the higher angles prevail. There are a few instances, however, where the greywacke is found at lower angles, as in the Broadly Hope, a tributary vale of the Hermitage, and on the Carter Burn, a little above its union with the Jed, the rocks in both places being for a short distance nearly horizontal, but soon regaining their usual inclined position. The general outline of the greywacke districts has been determined by this position of the rocks, especially in the basin of the Teviot above Hawick, where, the superficial alluvium being thinner, the rocky skeleton of the country has had more influence on its character than further east. It is here formed of numerous low ridges of rounded hills, with steep acclivities, running parallel to the general direction of the strata. The valleys of the Teviot and Slitrig, in the vicinity of Hawick are very characteristic, and by no means unfavourable examples of its scenery. Further west, particularly on the Ale and Borthwick, the country is wilder, more thoroughly pastoral, and less adorned with wood, yet still not without pleasing features, the hills being generally green, undulating, and diversified in appearance. The relations of this to the other formations will be noticed subsequently.

Teviotdale Red Sandstone.—For reasons which shall afterwards be assigned, we have chosen to give this deposit a mere local name rather than one derived from its supposed place in the series of geological formations. Though in some respects the most interesting rock in the county, it has almost a tiresome uniformity of mineral character and external aspect. It occupies a deep bay or gulf in the greywacke, which encloses it on three sides, whilst on the fourth it is shut in by hills of the trap formation. The most compact mass of this rock lies around Jedburgh, in the lower valleys of the Jed, Rule, and Teviot, extending along the latter to the east of Eckford and Roxburgh parishes. It also stretches north through Minto and Ancrum to the Tweed in St Boswell's and Maxton. It is, however, interrupted in many places by trap, which forms all the more important eminences, the red sandstone

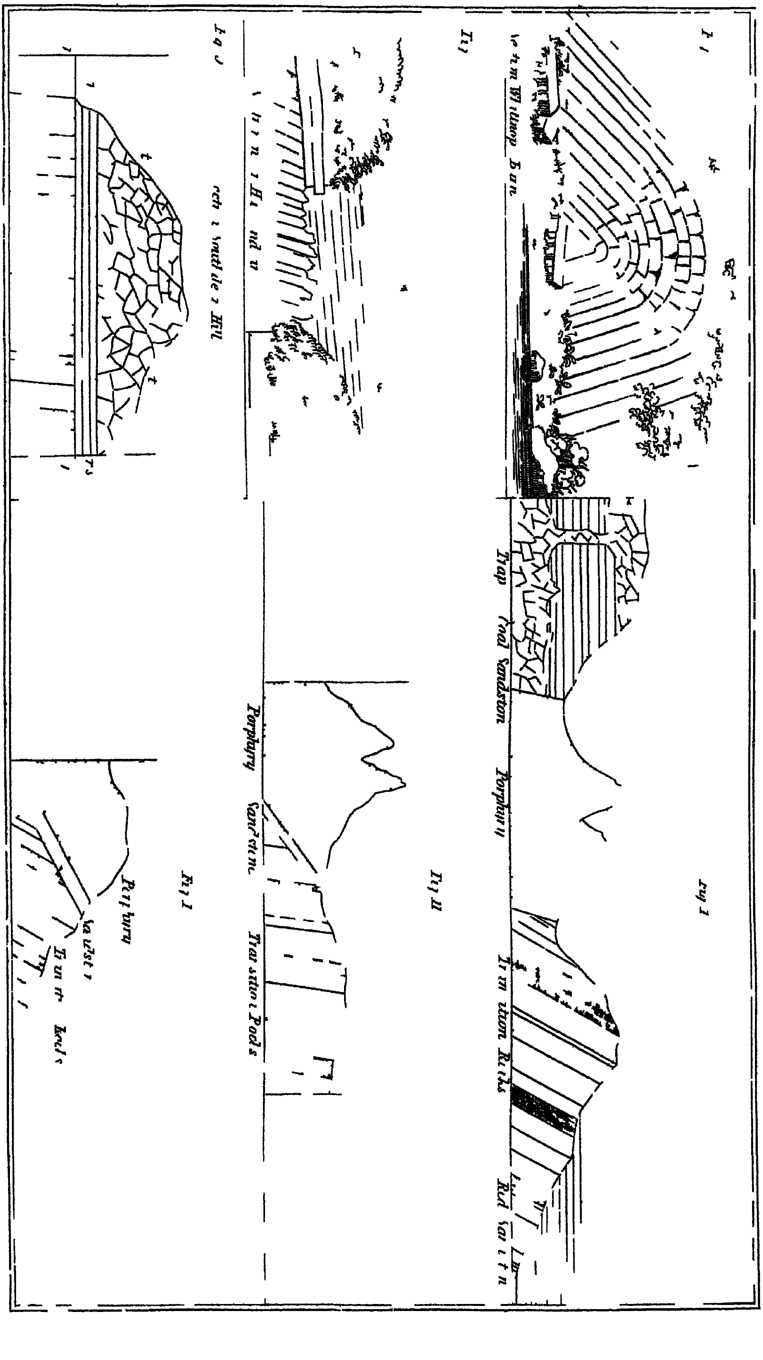
being principally found in the valleys and along the courses of the rivers. Taken as a whole, this formation may be described as a thick mass of sandstone and clay disposed in numerous, regular, distinct, alternating beds. In the lower portions, the sandstone, as seen near its junction with the greywacke, on the Tweed, Ale, and Teviot, is frequently a coarse conglomerate, composed of boulders of the greywacke and of felspar rocks, with a few others not unlike fragments of primary strata, in a very hard red or yellow coloured basis, mostly of felspar, with a little calcareous matter. The boulders are of various sizes, but most commonly from one to three or four inches in diameter, and compose the larger portion of the rock. These coarse conglomerates are, however, not very abundant in the centre or south of the formation, being more so on the Tweed, below Melrose, than in other places. There the conglomerate has altogether the aspect of the debris brought down by the river at the present day; and were this by any means consolidated, it would produce a rock wholly undistinguishable. So much is this the case, and so different is the aspect of some parts of this conglomerate from the red sandstone in the remainder of the county, that one is almost induced to ascribe this origin to them, especially as their relation to the other rocks is almost completely concealed below the alluvium. It is, however, a very hard, compact rock, and breaks into large fragments—some containing upwards of an hundred cubic feet—which may be seen strewed on the banks of the Tweed. This distinguishes it from the red boulder clay, which in other respects is not very dissimilar, but speedily crumbles down on exposure to the weather.

The larger part of this formation, however, consists of red and white sandstones, interstratified with loose sandy clays and marly rocks. Part of the sandstone, both red and white, is in thick beds, and, though generally soft, forms a good building stone, being quarried for this purpose at Belshes, Denholm Hill on the Rule, above Spittal, and at Caverton on the Kale. It is composed of minute grains of quartz and felspar, in a basis of clay and lime, all the varieties we have tried effervescing more or less with acids. The red varieties contain much iron, to which they seem to be indebted for their peculiar colour. Minute scales of mica likewise occur, but less abundantly than in the sandstones of the coal formation. Some of the white sandstone has a greenish tinge, probably from chlorite, and small black or dark green grains appear in it, resembling hornblende or augite. The materials of these rocks are thus pretty various, but their distinguishing characters are, a greater amount of felspar and clay, with a smaller proportion of quartz and mica, than are found in the carboniferous sandstones. These substances are in general

finely comminuted, but small fragments of red or greenish yellow clayslate appear even in the most compact varieties. The white sandstones are more common in the upper parts of the formation, cropping out before the red beds; but local peculiarities occur in regard to this, and in the quarries on the Rule, both seem covered by thin incoherent red beds. Some parts of the sandstone are variegated, the red being intermixed with lighter colours in strips or patches. The thickest part of the formation is, however, the arenaceous and marly clays. These are generally of a dark red or brown colour, are very soft, earthy, and incoherent, crumbling down readily when exposed to the action of the weather. Beds of a light grey, or straw-yellow colour, are often intermixed and seem to consist more exclusively of felspar debris, but a transition from them to the red is common. The aggregate thickness of these rocks is very considerable, as may be seen in the red "scaurs," especially those on the Jed, but individually the beds are thin, and seldom above one or two inches thick. They are interstratified with similar thin beds of more coherent sandstone, which serve as it were to bind the formation together, and project beyond the others in the steep banks, where, much exposed to the action of the weather, the rocks thus acquire a curious appearance, resembling the cornices and fretted work on some old ruin. One of the finest displays of this may be seen on the Jed, near a saw-mill above Kersheugh, and other parts of the banks of that river are little inferior. This appearance may have first suggested the caves found in the steep rocks in many places on the Jed, the Ale, and the Kale, these being evidently artificial places of refuge constructed by the inhabitants, probably during the constant border wars.

The thin regular beds of this formation are almost universally nearly horizontal, unless in the immediate vicinity of the trap rocks. No great general change of position, like that in the greywacke, or even in the coal formation, has taken place in its strata. Partial slips, breaks, and disturbances are, however, not uncommon, and are well seen in the *scaurs*, especially those on the Jed. This river seems generally to flow in a fissure formed along an anticlinal axis, whereas the Teviot follows the hollow produced by a synclinal axis, and in this way the different characters of the two river valleys may be explained. The former produces a deep narrow glen, with the strata frequently cropping out on its sides; the result of the other is a wide open valley, with gently sloping acclivities, on which the rocks seldom appear. It is a strong confirmation of this theory, that on the Jed the strata generally dip from the river on both sides, whereas on the Teviot the dip is, we think, more frequently towards it. In the former the change of dip may in some places be perceived even

PLATE III



in the bed of the river, as, for instance, a little above Ferniherst Mill. Near this a still more curious appearance occurs, the strata having apparently been elevated in one point, from which they dip in three directions, somewhat in the manner supposed in Von Buch's theory of elevation craters. One part of the beds dip 15° to S. 20° W.; another 12° to E. 15° N.; and the third 20° to W. 15° S.; their outcrop forming curves in the bed of the river. Not far from this is an anticlinal axis running N. 30° E., the rocks on both sides dipping from it at 48°. In many cases the strata have a twofold dip, forming ridges or curves with partial inclinations transverse to that peculiar to the whole bed. Sections of this kind are common round Jedburgh, both in the river banks and at a distance from it, as, for instance, near the road to Hunthill.* This appearance of the rocks has not, we conceive, received that attention it deserves, as it seems to indicate either that the superior rocks have expanded, or those on which they rest contracted, since the period of their deposition. Mere elevation would evidently have produced breaks and divisions in the strata, not the regular curves they now present. This appearance seems to furnish proof of the contraction in the interior crust of the earth similar to that supposed in the theory of its gradual refrigeration. Whether this would produce an amount of local contraction sufficient to explain all the phenomena, is a problem which we probably have not data enough to answer, and would lead to speculations in dynamical geology inconsistent with the nature and limits of this essay.

Besides the rocks now mentioned, *limestone* sometimes, though rarely, occurs in this formation. It was formerly quarried in the hill above Bedrule, where it seems inclosed in beds of hardened sandstone, lying below the greenstone forming the summit of the hill. The limestone is of a yellow colour and very porous, containing numerous drusy cavities, with veins of quartz, reddish jasper, and brown iron ore, and is evidently a highly metamorphic rock. The stone seems of inferior quality, and even were it otherwise, the expense of fuel would prevent it being wrought to advantage. This cause also interrupted the lime-works near Hunthill, said to have been in operation about seventy years ago. This rock seems, however, very rare in the red sandstone in a pure state, though calcareous matter forms one of its constituents, and is also common in veins, which, however, are less numerous than in the greywacke.

* In Fig. 5, Plate II., the elevation of the beds has produced a slip, a wedge-like portion of the rock sliding down and filling the hollow formed by the rising upwards of the strata. In Fig. 6, the beds remain continuous after elevation, and, therefore, the higher ones must have been brought nearer to each other. It is to the latter and similar sections we allude in the text. Both figures are from the Jed above Ferniherst.

This formation can scarcely be said to impart any peculiar character to the country it occupies, all the more prominent and remarkable features arising from the other rocks with which it is associated. As a horizontal deposit of no very great dimensions, it cannot be supposed to form high hills alone. Most of those in this district in reality consist of trap, whilst the sandstone appears as if embossed on their sides, or filling up the hollows between them, and has thus been not unaptly compared to an ocean of red waters studded with islands. In a few instances, however, it rises into long ridges, or round-backed hills, with gently sloping declivities, intersected by deep precipitous ravines, hollowed out by the rivulets which descend from them. The red *scaurs* already noticed, well seen on the Rule, Jed, Ale, Oxnam, Kale, and more sparingly on the Teviot, form its most characteristic scenery, and, when clothed with wood, are not without beauty, notwithstanding their disagreeable colour and almost total want of bold rock features. On the whole, however, it presents few points worthy of particular notice, whilst its connexion with the other rocks and probable geological age will be more conveniently considered in a subsequent part of this essay.

Coal Formation.—The rocks belonging to this formation, occurring in Roxburghshire, form two principal masses, the one in the eastern division, in the lower valley of the Tweed, the other in the south-western district, in Liddlesdale and the adjacent country. These, so far as we are concerned with them, are altogether unconnected, and we shall therefore describe them separately, beginning with the eastern or *Kelso sandstones.* These occupy the valley of the Tweed around and below that town, covering about a fortieth part of the surface of the county. The relations of the rocks composing this formation are very much obscured by a deep mass of alluvium accumulated in the low grounds in this vicinity. They, however, form a part of the same formation found in the neighbouring counties, and in this connexion have already been well described in the Transactions of the Highland and Agricultural Society,* so that a few short observations on them may now suffice. They consist principally of numerous alternations of sandstone, shale, and marly limestone, which are well seen on the south bank of the Tweed, and in some of the streams that flow into it, particularly Mellendean Burn. The sandstone is extensively quarried at Broxlaw and Sprouston, where it forms a good building stone. It is usually white or bluish grey, often inclining to yellow, more rarely, as near Shepherd's Bush, below Kelso, to red. It

* See Mr Milne's Essay on the Geology of Berwickshire, in vol. xi., p. 171, of the Transactions of the Highland and Agricultural Society.

consists principally of quartz and mica, in a basis of clay or felspar, some beds containing a large amount of lime. Much of it is rendered impure by carbonaceous matter, and it also contains some curious-looking fragments of a dark grey micaceous sandstone. The remains of plants and fossil wood found in it leave no doubt that it forms part of the coal formation, though, as stated in the memoir alluded to above, far below the level of the workable coal. In some of it, near Broxlaw, we observed cavities containing nodules of calcspar, surrounded by ochrey decayed matter, probably occasioned by the vicinity of trap. The shales are generally of a dark blue or grey colour, inclining, in some cases, to green, and in others, as above the sandstone at Broxlaw, to red. They are in thin beds, intermixed with the marly limestones. These are usually of a light grey colour, slightly tinged with green or yellow, but at other times are dark grey and very compact. The amount of calcareous matter is very variable, but some thin beds seen in the Tweed, near Bamff Mill, are tolerably pure limestone, and not unlike some beds of this found in the western district of the county. Limestone has been burnt in several places near Nottylees and Hadden, and is still quarried near the latter. It forms a thick irregular bed, dipping at about 30° to the N.E. towards the trap seen in that quarter, with which it appears closely connected. Its most calcareous portions are hardened, seem vitrified, and much mixed with siliceous matter, which is still more abundant in other parts of the rock, where it forms masses and veins of agate, semi-transparent flint, or pure white quartz crystallized in irregular pyramids. The whole bed has the aspect of a highly metamorphic formation, and is, we believe, far more intimately connected with the trap rocks than with the stratified deposits. It can be of very little economic value, and the attempts to use it prove little more than the scarcity of lime in this district. Mr Milne, in his account of Berwickshire, mentions a similar rock, also connected with trap, as having been wrought to the west of Smailholm, but without success, it containing so little lime that it would not pulverize; and we shall presently have occasion to notice others in the western part of this county.

The whole of this formation is very distinctly stratified, the shales and marls being generally in thin regular beds. The strata are seldom highly inclined, but both the dip and direction often vary considerably even within short distances. This seems to be occasioned by the trap rocks so prevalent in this quarter. In Broxlaw quarry, the sandstone dips at 30° S., and is divided by vertical lines running S. 35° W. In Sprouston quarry, the sandstone dips at 30° N. 40° E. towards and below the trap, but is much broken and confused;

the position of the blue shales above being also very irregular. Near Bamff Mill, they appear to be crossed by an anticlinal axis, the rocks above dipping at 8° to W. 10° S. and below at 30° to S. 60° E. The natural features of this part of the county depend far more on the trap and alluvium than on this formation, which they almost entirely conceal. It seems to be chiefly confined to the low land along the river, though its limits are often very obscure.

The *Liddlesdale Sandstones*, also belonging to the coal formation or old red sandstone group, occupy a far larger portion of the county than the rocks now described. They compose most of Castleton parish, and a considerable part of Southdean, and the upper division of Jedburgh, stretching along the south-western border of the county. Their extent is about 130 square miles, or less than a fifth of the whole shire. They are in a great measure merely the outcropping beds of the carboniferous rocks of Northumberland and Cumberland, the physical divisions being here different from the political. In his geological map of Scotland, M'Culloch regards part of these beds in the north and east of Liddlesdale as belonging to the old red sandstone, and the remainder to the coal formation. In many parts of Scotland these two deposits are separated by very distinct characters; but, in this county, we must acknowledge that we have not been able to perceive any good grounds for this division, or any principle on which it could be effected with even an approach to accuracy. The whole seems to form one series, without break or interruption, and the fossils are far too few and indistinct to serve as the basis of a division. Neither can we assume his division, which, we are afraid, has been formed without a sufficient knowledge of the rocks in this county, which he does not appear to have examined with his usual accuracy. Some of the beds in the upper parts of the county, as near Windburgh, resemble the old red sandstone, both in colour and other respects, but this may in part be the result of their proximity to the trap; and, in the burn below Robert's Linn, we observed some blocks of sandstone, worn, however, by the water, with impressions of plants, belonging, we conceive, to the coal formation, one of them being a Sigillaria. Near Dawstone Rig, the lower bed also strongly resembles the old red sandstone, but the beds that overlie it have more similarity to the under coal formation. This is also the character of the sandstones on the Carter, and of that immense mass of this rock which forms the hills round the Tarras in Dumfriesshire, between Castleton and Langholm. Hence we conceive that these rocks, having, so far as appears, been *formed under similar continuous conditions*, may, with most propriety, be regarded as one formation, they possessing everything essential to constitute them

such. Their age may correspond to the latter red sandstone and earlier coal formation, but all of them lie below the true workable coal. A thin bed of this mineral was attempted to be wrought to the south of Stob's limery, but without success. That wrought on the top of the Carter, above Meadowcleugh lime-work, is also thin and of a bad quality, and, with that at the head of Kerry Burn, on the very outskirts of the county, probably belongs to the same part of the series.* Hence we conceive that, with the exception of a very small portion perhaps of those in the extreme south-western angle of the county, all the strata here lie far below the true coal measures, and that there is no hope of this valuable mineral being ever found to any extent in this quarter of Roxburghshire.

Viewing these rocks as constituting one formation, or continuous series of strata, they may be described as consisting of sandstone, shale, and limestone. The sandstone is principally white or yellowish, often becoming red when exposed to the weather, and appears to compose the great bulk of the formation. The beds are mostly thin, but some, especially near the bottom of the deposit, have considerable dimensions. Near Windburgh, it is in part hard, coarse, and gritty, in part red, iron-shot, and of a soft friable texture, so as to be unfit for any useful purpose, and has evidently been affected by its vicinity to the trap composing that hill. Where it first appears on the Hermitage Water, and westward towards Dumfriesshire, the sandstone has more the aspect of that belonging to the coal formation than the old red sandstone, being fine-grained, white, and of a yellow rather than a red tinge. This is also true of that in the Carter, both above and below the limestone, though parts of it here are stained of a light rose red, and hardened by the action of the trap. Some parts of it shew traces of coal plants, but these remains are neither numerous nor well preserved. Other sandstone beds are thin, of a dirty grey colour, and much intermixed with blue and grey shales. Good sections of these rocks may be seen in the upper part of the Liddle, above Lariston, and in Whithope Burn, above Hermitage. Both the sandstones and shales much resemble those in the under part of the Mid-Lothian coalfield, especially the beds seen cropping out on the south side of the Pentlands. The sandstone contains much mica and clay, with a considerable proportion of lime. Thin beds of limestone are also common, and others of greater thickness (10–14 feet) are

* The true age of the English formations in this part of Northumberland does not seem very well ascertained. Conybeare and Phillips refer them to the millstone-grit, and the appearance of the formation in Roxburghshire is not opposed to this opinion. At all events, they are below the great coal formation on the Tyne, in Northumberland.

wrought in many places. Some of these limestones are of a grey or yellow colour, and much intermixed with sand and mica. Others, like that at Lariston, believed to produce the best lime in this district, are of a dark grey or blue colour. The strata there are nearly horizontal, and shew few marks of disturbance, but the rock is very hard, and the shells in it almost obliterated, whilst cavities filled with iron pyrites and calcspar, sometimes crystallized in acute pyramids, remarkably beautiful, are formed. In some of the limestone near here, large ammonites are said to have been found; but fossils seem by no means abundant in any of the rocks in this district. The only bed of an opposite character is one of dark, almost black, limestone found in several parts of the Liddle, above Thorlie's Hope, which consists in a great part of minute shells. In a specimen of it at Hudshouse Rig, we also found teeth or scales of fishes. This rock contains sulphuret of iron, and has a strong fetid smell when broken.

At Stob's limery, the rock, which rests on hardened sandstone,* is of a light yellowish grey or greenish colour, intermixed with grains or veins of pure crystallized calcspar. It is in part about fourteen feet thick, but thins out, and becomes broken and disturbed, towards the east, where trap rocks appear. It also contains irregular cavities lined with fine crystals of calcareous spar, often coloured red. We observed no fossils in this rock or those immediately associated with it. In a small rivulet to the east of this is a curious example of the changes produced on the strata by igneous rocks. The stream, one of the sources of the Slitrig, forms a considerable fall, known as Robert's Linn, in the ravine below which the rocks are well displayed. The highest seen is a thick bed of dark-coloured greenstone, which rests on a bed known as the Jasper Rock, and this on thick masses of incoherent sandstone, mostly red, with patches of yellow. The Jasper Rock consists of veins of red agate or chalcedony, mixed with greenish clay, lime, and quartz sands, and we have no doubt is one of the marly limestones common in this formation, altered by the trap. The siliceous portion bears a strong resemblance to that found in the limestone near Hadden, but the latter contained more calcareous matter. Similar rocks occur further west, and we also saw them in Riccarton Burn and in the hill near Old Saughtree, where, along with the red, there was also compact milky flint, approaching to white chalcedony. The rock at Robert's Linn was formerly much sought after as an orna-

* This rock is very extensively used for repairing the roads in this quarter, although in the immediate vicinity of the trap of Windburgh, in every respect preferable for this purpose. This is only one out of many instances of the utter inattention to the simplest geological facts, and the practical disadvantages thus occasioned.

mental stone, but is too much mixed with extraneous substances, and too splintery, to be of great value for this purpose.

Meadowcleugh lime-work, though, from its position, of considerable economic importance to the central parts of the county, presents few points of interest to the geologist. The Carter Fell consists of nearly horizontal beds of sandstone, rather inclined to the south, which are covered by a capping of dark greenstone. The limestone is found interstratified with the sandstone, and is now wrought by a mine. It very much resembles that at the Stobs limery, and, like it, contains no fossils. Some of the beds are arenaceous, and one is a limestone breccia, of angular fragments, in a calcareous basis. The geological structure of the Carter is of some importance in reference to the project of improving the communication with England by means of a tunnel through it. The centre of the hill we have no doubt consists of trap, to force a passage through which would be accompanied with enormous expense. On the east, below where the present line of road crosses the hill, it seems to consist entirely of the horizontal sandstone which would, on the other hand, as much facilitate the operation; and this is the part of the hill best adapted in other respects for a tunnel. No limestone beds have yet been observed here, but such may be concealed by the alluvial covering. Were such found in a fitting situation, the materials would repay the expense of their removal, and greatly lighten the cost of the undertaking. The importance of this is such, that it may well excite surprise that no thorough investigation, by boring and otherwise, of the geological structure of this natural barrier between the two kindgoms has ever been accomplished.

The strata composing this formation generally dip at low angles towards the south and west, except in the vicinity of the trap rocks, where they are more highly inclined. Where first seen on the Hermitage Water, they are almost horizontal, but the southerly dip soon becomes more apparent. Where first met with on Dawstone Rig, the dip is 8° to S. 10° W., but lower down it is more nearly horizontal. The fetid limestone formerly mentioned, where first seen, dips at 5° to S. 40° W., and is divided into oblong blocks by lines running W. 30° S., and S. 30° E.; but at some distance below it is found dipping eastwards at a very low angle, (1°—3°.) In Thorlie's Hope, some of the beds, on the other hand, are for a short distance nearly vertical, and on the Liddle, below Castleton, thick beds of white sandstone and limestone dip at 45° S. 40° E. away from the trap in Lawston Hill. In Whithope Burn similar high angles, with changes both of dip and direction, are not uncommon, and in one instance

are very distinctly shewn in a small space.* Here the sandstone strata form a complete curve, dipping on the one side at 80° to the W., and on the other at 40° to the E. At the curve, the beds are somewhat fractured, but less so than might have been looked for, and no doubt of their connexion can be entertained. The beds, however, appear to have been in some degree consolidated before the inflection took place.

The usual idea entertained of a district of country belonging to the coal formation is that of a low-lying, richly-cultivated land. This, however, is wholly inapplicable to that we are now considering, much of which is raised high above the level of the sea, whilst nearly the whole remains almost in a state of nature, untouched by the hand of improvement. A large part of Liddlesdale, as already mentioned, is a pastoral region, covered with the natural vegetation. The hills in this portion of it are less abrupt and lofty than in the greywacke formation, and the soil in the low ground is deeper and apparently more fertile. But the aspect of the country is far from being improved on the whole, the higher parts of it being the most barren, impassable, and uninteresting in Roxburghshire. The greywacke hills are generally covered with short thick grass, not unpleasing to the eye, and affording a firm hold to the foot; but in the sandstone district, the moist soil and long matted herbage impede the traveller's steps, and render his progress toilsome and difficult. Higher up, this rank vegetation gives place to soft moors, or "flows," as they are named here, saturated with moisture even in the driest season, and rendered still more impassable by the deep "moss hags" intersecting them in every direction. The fells, on the borders of England, and the hills between Roxburghshire and Dumfriesshire are for many miles entirely of this character. The whole region north and west of the Tinnis Hill, around the sources of the Tarras, through which the road from New Castleton to Langholm passes, is not surpassed, in the uniform monotony of its dark moors and impenetrable morasses, by any region in Scotland. It more resembles the Black Mount between Argyle and Perth than any other district we have seen, but the huge blocks of white sandstone, which alone diversify its surface, cannot compensate the geologist for the varied aspect of the granite, gneiss, and porphyry found on the other. In these solitudes the moss-troopers of former times found a secure retreat from their enemies, whilst the similar country on the English border formed an impenetrable barrier, which no invading army could pass, and thus probably had no slight share in enabling the south of Scotland to main-

* Fig. 7., Plate III.

tain its political independence. The cause of this peculiar character of the sandstone districts lies in the horizontal and unbroken stratification of this rock. The whole rain is thus retained on the surface, and cannot escape through cracks or fissures, nor sink into the interior between the inclined strata, as in the greywacke country. The same circumstances also account for the comparative scarcity of springs in all the sandstone districts of Roxburghshire.

These, with the exception of the recent alluvial formations, are all the stratified deposits observed in this county, and we now proceed to describe the igneous formations. These are divided into two classes, the *porphyry* and *trap* rocks; the former characterized by the predominance of felspar in their composition, the latter of augite. The line of distinction is, however, in some measure arbitrary, both classes being compounds of these or related minerals, and rocks occurring within the limits of each division, which, were their composition alone to be regarded, might more properly be classed in the other; thus occupying the place assigned them rather from their local associations and external configurations than internal structure. The transitions from the one series to the other, and the connecting links, are indeed so numerous, especially where the two formations approach each other, that we have felt some difficulty in fixing their proper limits, and have often been disposed to regard them as one. But, on the other hand, the extremes of each are very distinct, and they possess so many characteristic differences, particularly in external aspect and configuration, that it seemed better to separate them, notwithstanding the risk of error in individual cases, and the high authority which might be assigned for the contrary procedure. The difficulty is one which meets us in all attempts to classify the unstratified formations, whose mineralogical character seems in many cases to have been determined more by accidental circumstances than original differences of constitution.* Even if unfounded in nature, however, the mere distinction of colour on the map can be productive of little inconvenience to those who regard the formations truly identical.

The *Porphyry Rocks* of this county form three subordinate divisions, the transition, the Cheviot, and the Eildon porphyries, distinguished, not only by local position, but also by peculiarities of character. The first, or transition porphyry, is far from being abundant in Roxburghshire, and has no great influence on its geological character. We have only observed it in the high hills

* "The definite divisions of rocks are speculations of the cabinet, not the truths of nature on the great scale; and to define what she has not separated, is to construe systems, not to record facts."—*M'Culloch's Memoir with Map of Scotland*, p. 70.

on the north-west border of Liddlesdale, and especially at the extremity of the county near Mosspaul Inn. In the remainder of the greywacke region it seems wholly unknown, and even boulders of it are rarely found in the streams. The Wisp Hill, with others around the head of the Ewes Water in Dumfriesshire, seem to form the centre of igneous activity from which the rocks of this class found in Roxburghshire are mere offshoots. There is a fine display of them, and of the bold striking forms they confer on the greywacke hills, between Fiddleton and Mosspaul, and thus beyond the limits of this county. East of the latter place, however, they have been quarried to some extent for the roads; but soon disappear; and, as we descend towards Hawick, nothing is seen except greywacke and slate in regular strata. The change in the external aspect of the hills on the Teviot from those in the neighbouring county is very striking, and at once reveals the difference in their structure. These rocks do not, however, so far as we can judge, form by themselves any of the high hills, which they have principally influenced by the superior hardness and consistency they have conferred on the greywacke. Their true place is as beds or veins among the transition strata; and they are more often seen in the hollows between the mountains than on their summits. The deep narrow defile, which, for a long distance west of Mosspaul, runs almost in a straight line between high mural hills, and alone renders a passage from the basin of the Teviot to that of the Esk possible, is evidently connected with their appearance. They are also found in the mountain pass to the east, whose name of the Queen's Myre is still connected, in the traditions of the country, with one of the mishaps which befell the unfortunate Mary in her adventurous ride from Jedburgh to Hermitage. These rocks present more uniformity of mineralogical character in this county than in other parts of the transition mountains. They consist almost entirely of compact felspar, varying in colour from a deep clove-brown to a light yellowish red. They are also of a more earthy and incoherent texture than farther north, though some varieties are pretty compact, and contain numerous felspar crystals in the base of that mineral. The greywacke rocks near them are often coloured red or ochrey yellow, and either hardened or rendered more liable to decay.*

The *Cheviot Porphyries* occupy a far more important place in the geology of Roxburghshire, covering a much larger portion of its surface, and exhibiting a greater diversity of mineral character. They compose most of the south-eastern angle of the county, from the upper part of Jedburgh parish to the English

* For a fuller account of these rocks the author would refer to his "Essay on the Geology of Peeblesshire," vol. viii., p. 149, of the Transactions of the Highland and Agricultural Society.

border beyond Yetholm, comprising in all this a large part of Linton and Oxnam parishes, with the whole of Hounam and Morebattle. Their superficial extent is thus about 105 square miles, or a seventh part of the whole county. The porphyry presents more variety in its appearance and character than any of the rocks we have formerly described, and it is more difficult to give any general account of it. The basis consists principally of compact felspar, mixed, however, with iron and hornblende, minute acicular crystals of the latter sometimes appearing in the mass. Its colours are various shades of brown, purple, red, becoming yellow when decomposed, and greenish grey. In this are more or less numerous crystals of common or glassy felspar, generally white, or of a lighter colour than the basis. Minute crystals of mica also occur in some varieties, though rarely. Some parts are, as it were, completely saturated with veins and nests of siliceous matter, principally red and white chalcedony, with pure, transparent, crystallized quartz. This is so abundant, and so minutely and intimately mixed with the basis of the rock, as evidently to constitute one of its original elements, though, in many cases, much resembling sinter deposited from water. In some varieties, small portions of green prase (?) and rose-red quartz also appear. These siliceous substances, being less easily acted on by the weather than the felspar basis, are often finely displayed in consequence of the natural decomposition of the stone. Besides these, porphyries, with a very dark-coloured basis, occur. This has, generally, a greenish tinge, but is sometimes almost black, and passes into a kind of pitchstone, like that of Arran, but with less of the resinous lustre, and more numerous distinct felspar crystals. Narrow veins of red jasper, sometimes accompanied with others of quartz, often traverse this variety of the rock; and similar veins of ferruginous quartz, resembling rusty iron, are not uncommon in the division lines between the masses of the porphyry. At the opposite extremity to those are some claystone porphyries, which, however, do not seem very common. These have an earthy basis of a light yellow or grey colour, and the embedded crystals are indistinct, resembling grains of sand, so that this variety might almost be taken for a conglomerate. A rock truly of this character is sometimes met with on the outskirts of the formation, as above Edgerton, where it forms thin beds, dipping irregularly from the porphyry hills, like sand deposited on an inclined surface. It is red or yellow, with white spots, and not unlike the red sandstone, but looser, and more decomposed, and is, apparently, a mere local formation, the result of partial and accidental causes. In general, the porphyries, especially the lighter coloured ones, are very liable to decomposition, so that it is hardly possible to procure a specimen with a fresh surface of

any size. This is particularly the case with some in the Grubit Hills, above Morebattle, where, in quarries, although the rock has not been long exposed, it is yet divided to a great depth by irregular fissures, and, consequently, only breaks into small angular fragments with withered surfaces. This mode of decomposition is the more curious, as the stone is otherwise perfectly fresh and unaltered.

These rocks differ much from the former, or transition porphyries, both in mineral character and external configuration. In both they appear to approach the trap, whilst the former are more closely allied to the granite. They do not occur as veins or detached beds in other formations, but rather as separate independent masses, occupying a distinct region by themselves. They then form hills, arranged two or three together in linear groups, which again unite to form other groups, also placed in straight lines. The hills are generally conical, with a rounded outline composed of curved lines, with their convexity downwards, or to the interior of the hill. Their acclivities are often steep, but seldom rocky or precipitous, though this character is found in several parts of the formation, in particular to the south of Kirk Yetholm, where some have rocky escarpements like those in trap hills. The general direction of the porphyry is to the N.N.E., as is well seen in the courses of the streams in this district, especially the Kale and Beaumont. The valleys are, in general, narrow and long, though others, like that at the head of Oxnam Water, are more extensive and level. Some of the hills also are flatter and rounder than is usual in this formation, more resembling those of trap or greywacke. They are, for the most part, clothed with short thick grass, and form the finest pastures in the county. Hence, though containing no bold or remarkable scenery, the porphyry hills are distinguished at a distance for their picturesque and even elegant outline, and, nearer hand, for their beautiful, retired, and pastoral valleys. The higher portion of the chain on the south is, however, of a wilder character, and more overgrown with dark heath.

In the hills north of Yetholm, a kind of intermixture of the trap and porphyry formations seems to have taken placed. Some of the rocks there so much resemble the former, and others the latter, that some doubt may be entertained to which of them this district more properly belongs. We were, at one time, inclined to consider it as trap, which, in consequence of the proximity of the porphyry, had acquired somewhat of its aspect, but now think that, on the whole, the rocks have more affinity to the latter. Some portions are undoubted basalt or greenstone, but others, of a dark black colour, appear different, as those in the hill east from Frogden, which contain so much lime as to effervesce with

acids. Thirlestane Hill consists of a similar dark green rock, with veins of quartz and nodules of agate, so characteristic of the porphyry. It, however, also contains crystals of hornblende or actynolite, with veins and nodules of calcspar; in this again approaching to the trap. These dark-coloured rocks are more easily fusible than basalt, from which, in aspect, they differ little, the lime perhaps acting as a flux. The hills on the north side of the Beaumont, below Yetholm, consist of reddish porphyry, not unlike some varieties of greenstone, and sometimes appear to contain fragments of lighter coloured porphyry, or nests of red felspar mixed with a greenish mineral. Near Venchen, the rock has a dark reddish green basis with crystals, some light green, others nearly white. In Yetholm Law it has much the aspect of a greenstone prophyry, and contains a vein of sulphate of barytes, found both on the top and at the foot of the hill on the east. Near Bankhead, again, it is a mixture of greenish grey and light red felspar, and near Kersknow consists of a brown basis with white crystals. Most of these individually might, in other relations, be regarded as trap, but, on the whole, the characters of the porphyry prevail, and we have, consequently, united them to that formation. At the same time it must be understood to contain rocks which singly more resemble trap, and might have been so named. In external features, also, the hills differ from those south of Yetholm and Morebattle, being flatter, squarer, and more undulating in their outlines. They are also circularly disposed, and not in straight lines, and thus form deep amphitheatrical valleys converging to a centre on all sides, in the bottom of which we find either lakes*—almost unknown in the rest of the county—or deep deposits of sand and peat. These facts, with the change of direction in the Kale and Beaumont, render it not improbable that these hills form either an intermediate formation, or that the trap has here intruded at a latter period among the porphyry. The latter appears the more probable theory, as some of the southern chains of hills are continued into this district, across the deep hollow connecting the valleys of the Kale and Beaumont.

In mineralogical character, and also in the peculiar form of the hills, the porphyry of the Cheviots bears a considerable resemblance to the trachyte formation. Taken generally, however, the porphyry is of a more compact and crystalline texture, contains more siliceous matter, and is of a darker colour than the trachyte.

* Linton Loch should not be included among these, as it has more probably been formed by the debris brought down by the Kale filling up the valley to the west, where it turns at an acute angle. It would even appear that these lakes, and, consequently, the hills are of later origin than the great mass of the alluvium, which seems more than sufficient to have obliterated them.

It also wants those gigantic crystals of glassy felspar and hornblende which distinguish the trachyte in many places. In many respects they seem to form a class intermediate between the old highly crystalline granites and the recent porous trachytes, shewing that they have originated in circumstances more favourable to condensation than the latter, but less so than the former. They have thus been, in all probability, formed below the ocean, as the granite in the centre of other rocks, and the trachyte in the open air—a theory which, in regard to our own rocks, will be confirmed by some facts to be mentioned subsequently. Compared with similar formations in our own country, they bear some resemblance to the claystone porphyries of the Pentlands, but are in general harder and more compact. In the latter, the basis of the formation approaches nearer to clay, and is more liable to decomposition than the Cheviot porphyries, which are more granular in their texture and exhibit a much higher lustre. The southern formation is also far more varied in mineral character, possessing many rocks, as the dark pitchstone, to which nothing analogous is found in the north. They have a far closer resemblance to the porphyry rocks of Glencoe and Ben-Nevis, from some of which they are hardly distinguishable in mineral character. Thus some of the dark porphyries of Woodside Hill, on the Beaumont, are almost identical in appearance with that forming the upper part of Ben-Nevis, which, in some places, also contains red masses similar to the veins in the porphyry of Kirk Yetholm Hill. Similar dark rocks are common in Glencoe, where most of the brown and red varieties may be also matched, confirming the truth of M'Culloch's observation,* that in that glen, porphyry of every variety of colour and composition, found in any other part of Scotland, also occurs. Even in their conical form, the Buachaile Etivemountains resemble many of those in the Cheviots, though on a far grander scale, and with a great predominance of the harsher features. The differences, however, in the two formations are not more than the rocks with which they are associated would lead us to expect; less indeed than between the greywacke and coal sandstones of the south, and the granites, gneiss, and mica slate of the north.

The *Eildon Porphyries* constitute our third sub-division of the felspar rocks, and are separated from the others almost as widely in mineral character as local position. This group of hills is in many respects the most remarkable in the south of Scotland, and their fame in legendary history is fully supported by the peculiarity of their physical structure.

Though by no means very elevated, the highest only 1364 feet,

* "Geological Transactions," (1st series,) vol. iv., p. 131.

the Eildons, from their isolated position, are visible through a wide range of country, and command a prospect of most of the lower basin of the Tweed and Teviot.* According to our view of those hills, they lie wholly in the greywacke, hardened beds of which may be seen in the burn behind the town of Melrose, rising high up on their sides. The same rock may be traced round them on the south, but on the east, the thick alluvium renders their relations more obscure. They are, therefore, found associated with the same stratified deposits as the first class of porphyries, but, nevertheless, are very different from them in most respects. The rock consists of compact scaly felspar, sometimes passing into claystone. It is generally of a yellowish red or brown colour, varying, however, even in specimens from the same quarry, and changing almost visibly on exposure to the air. In this basis are crystals of felspar, and more rarely minute ones of quartz and hornblende, when it becomes almost a very fine-grained sienite. The amount of those minerals is, however, always inconsiderable compared with the felspar basis, so that the rock may be considered rather as a compact felspar than a porphyry. It has generally an even or conchoidal fracture, but some varieties are uneven, or large granular, as it may be called. On the large scale, the rock is massive, but very often with a tendency to form beds, sometimes becoming almost slaty. This structure is common in the porphyry formation; but here it is in many cases so regular, and so much resembles stratification, as almost to induce the belief that part at least of the porphyries are altered transition strata. In a quarry on the south-western corner of the smallest hill, above the village of Bowden, the felspar forms beautiful columns, with from three to five or more sides. They are less regularly formed, and the angles not so acute, as is common in the trap rocks; their dimensions, however, are very constant, appearing at a little distance like vertical strata. They are pretty uniform in mineral composition, though some slight differences occur even in columns in contact with each other. This is the only instance of a columnar structure which we have observed in the porphyry, but both it and the irregular beds are common in the trachyte formation.† The form of those hills is a very good example of that characteristic of the porphyry, and, as such, requires no further notice.

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* Next to the view from the Eildons we should place that from the Dunian, near Jedburgh, and then that from the Grubit Hills on the outskirts of the Cheviots. In the western district of the county, that from Tinnis Hill, over Dumfries and Cumberland, with the noble estuary of the Solway, is perhaps equal if not superior.

† We allude here to the trachyte formation of the Siebengebirge, on the Rhine, where we have alone seen this rock *in situ*. The columnar structure of the Wolkenburg, of which a view is given in "Leanhark's Popular Geology," is by no means so distinct as that of the porphyry on the Eildons.

On the north side of the Eildons, west of Melrose, is a low hill which has been quarried to a considerable extent. The rock here consists of fragments, mostly angular, or only slightly rounded, of the porphyry and greywacke rocks; and, though sometimes named a conglomerate, is properly a breccia. The fragments are enveloped in a felspar basis, which seems to have been ejected in a state of mud. It resembles, with some slight peculiarities, the tufa rocks found in Arthur's Seat, and others which we shall presently notice among the trap formations of this county. Similar breccias are not uncommon in other porphyry formations, and, as they always occur on their margin, are supposed, with much probability, to have been formed by friction, during the ejection of the central mass. This explanation is not inapplicable here, especially as the rocks appear to become more felspathous in the interior.

We have now arrived at the *Trap Rocks*, the last class of regular formations in Roxburghshire, in the geology of which they occupy a far more important place than is usually supposed. They not only form the tops of a few of the more elevated hills, but, in the east of the county, also most of the high undulating land beyond the immediate banks of the rivers. The extent assigned to the trap is the most important innovation resulting from this survey. In most accounts of the geology of Roxburghshire it is assumed that the red sandstone in the basin of the Teviot formerly described is connected with rocks of a similar colour in England, and this is usually considered as decisive of its age. After a careful investigation of the whole eastern border of the county, from the Cheviots to the Tweed, we are compelled to reject this opinion. No rocks except trap appear, and sandstone is never met with, even a stray boulder of it being very rare. Instead of the English red sandstones penetrating into Scotland in this quarter, we believe that the reverse is the case, and that the porphyry and trap of Roxburghshire also cover a considerable portion of the neighbouring county. North of the Tweed, the trap is also found in great profusion, covering the whole country, except the low ground along the river, occupied by the coal sandstones formerly described. These districts join with another hardly less extensive, in the peninsula between the Tweed and Teviot. With the rocks of the same formation in Berwickshire we believe that they will be found entirely to shut in the red sandstone formation of this county. Further west, the trap occurs in more insulated portions; but it is still a very remarkable feature to the borders of the greywacke. With the Liddlesdale sandstones it again appears, forming the lofty summits round the eastern margin of this formation, and several

hills within it. This short review, to complete which we must refer to the map, will shew the important place we have felt compelled to assign to the trap rocks in the geology of Roxburgh, thus altering almost its entire aspect. We have some diffidence in proposing changes of such extent in reference to a district which, from its local position, might be supposed well known. This is increased by the difficulty which the great depth of the alluvial covering, and the highly cultivated state of the country, often place in the way of the observer, preventing the certain determination of the inferior rocks. This must form our excuse should subsequent investigations prove that we have, in some instances, failed in discovering the exact limits of this formation.*

The trap rocks of this county present no great diversity of mineralogical character. Most of them are a dark compact greenstone, passing into basalt, with few peculiarities to distinguish that found in one locality from that in another. Some of them appear to consist of hornblende and felspar, (diorite,) others of augite and felspar, (dolerite;) but the crystals are so minute and intermixed as to render their determination uncertain. Some of the varieties, however, appear more interesting. In Wooden Hill, south of Eckford, there is a very beautiful dark rock, containing large splendent crystals of common felspar. At Bellobutts, near Ancrum, the basis is light green, with large distinct crystals of glassy felspar, and concretions also, we think, of the same mineral. The trap of Carby Hill, on the borders of Cumberland, below Castleton, much resembles that of Wooden, but is less splendent and beautiful. In that composing Bonchester Hill, crystals and concretions of felspar and olivine appear. Near the stratified rocks the trap often becomes amygdaloidal, even when this is not its general character, as is seen in the dark greenstone of Windburgh Hill, near the limestone, in that near Hadden, and also at Moorhouse Law, south of Maxton. The latter is seen very distinctly resting on the sandstone, both being quarried in the front of the hill. It contains curious round concretions of calcareous spar and quartz; and also many veins of rose-red carbonate of lime and magnesia, mixed with steatite and quartz, the latter often distinctly crystallized. Below Sprouston

* We have been much confirmed in the accuracy of our views on this subject by the map accompanying Mr Milne's "Essay on the Geology of Berwickshire." He has extended the trap rocks of that county and of the north of Roxburgh far beyond what formerly was considered their proper limits. The differences between his map and that accompanying this essay are probably not more than might be expected from different observers, and in several cases are, we conceive, more apparent than real. In the summary of the "Geology of Roxburghshire," annexed to the "Statistical Account," it is stated that, in the red sandstone district, which there includes all the trap in the east of the county, trap rocks are common every mile, or even every half or quarter mile. This statement is true so far as regards the trap, only we have found no proof that the red sandstone exists along with it.

there is also an amygdaloid, apparently resting on the sandstone, and many of the beds of trap found in the coal formation of Liddlesdale have the same character, shewing the influence of the stratified on the unstratified formations with which they are associated. Some of the most curious trap rocks in the county are found near Stitchill. They are generally a compact greenstone, with many crystals of felspar and olivine, but some parts appear veined with dark brown and black in concentric layers. Near Mainrig, on the Eden, it also contains small fragments of clayslate and greywacke, rather a rare occurrence in the trap rocks.

Tufa is sometimes, though rarely, found in this formation. Tinnis Hill, on the borders of Dumfriesshire, seems, from its rounded form, to consist principally of this rock, a dirty grey variety of which, very much decomposed, crops out on the southern acclivity. On the top, however, in a kind of circular cavity, there is a large collection of stones, mostly basalt and sandstone, but as no fixed rocks appear, this is probably artificial. Minto Hills have the same rounded form, and the top also consists of a yellowish grey earthy tufa, containing many fragments of the greywacke and a few of trap, but none, so far as we observed, of the sandstone which forms the greater part of the hills. Though the sandstone is much hardened, the greywacke, with veins of calcspar, is apparently unaltered, though inclosed in the body of the rocks. Near Trony Hill, and on the north side of Lanton Hill, the top of which is the dark greenstone, tufa again appears. Behind Ancrum Craig House, a yellow-coloured variety of it is seen, containing numerous fragments of felspar, quartz, sandstone, and trap. This rock has much similarity to that formerly mentioned as connected with the porphyry of the Eildons. It generally appears in tabular masses, or even in beds, almost with a slaty structure, which seems in part the result of decomposition, to which it is exceedingly liable.

Behind the old tower of Timpendean, a very compact clinkstone, unlike any of the other trap rocks in this county, occurs. It is very hard and splintery, breaking with an uneven conchoidal fracture and a ringing sound. In the same place a rock of light red felspar, with a few scattered grains of quartz and green earth, and scales of mica, is quarried. We have observed nothing at all similar to this rock amongst the trap, and it far more resembles the felspar porphyries in the transition strata than any other formation in the county, though widely separated from them both in situation and geological association.

In this county the trap generally forms thick beds or tabular masses, with an irregular prismatic structure. Hence they readily decompose into roundish quadrangular blocks, with which the

whole surface is often almost entirely covered. In the east of the county, on both sides of the Tweed, it seems to compose the whole country, having wholly expelled the stratified formations. At other times it overlies these, forming the summits of the hills, whilst they appear in the valleys between. This seems to be the case in the district from Roxburgh south-west to Penielheugh and the Ale, in Ancrum Moor, and in Lanton, Bonchester, Southdean, the Carter, Windburgh, and some other hills. The tufa, in the localities enumerated above, seems also disposed in the same manner. More rarely it appears to form huge veins rising through the strata, without spreading over them, as in the Dunian, Ruberslaw, Greatmore, and a few other hills. In Ruberslaw, we think there are at least two of these veins, running north-east and south-west, parallel to each other, and forming, the one the eastern, the other the western, summit. The rock in these differs somewhat in character, that in the western or lower hill being finer grained, more compact, and of a darker colour. It also breaks readily, with a scaly conchoidal fracture, whilst the other is very tough, and broken with difficulty into irregular polygonal pieces. Even in the higher hill alone, we conceive that more than one vertical mass occurs, producing the jagged broken outline by which it is distinguished.

In the Liddlesdale sandstones, veins of trap, both in beds and dykes, are very common. One of the latter crosses the strata containing the fetid limestone, near Hudshouse Rig on the Liddle, but produces little change on their inclination. It runs E. 80° S. in the direction of the Dead Water, on the border of Northumberland, with the spring at which it and the limestone are not improbably connected. In Riccarton Burn, south of Ernton Hill, many beds of basalt and amygdaloid are found in a red sandstone which is hardened and broken. Similar dykes and beds are found in other parts of this district, as in Thorlie's Hope, near Castleton Manse, and in the hills on the borders of Dumfriesshire, west of Tinnisfell. In the east of the county, trap veins are far less common. There is one, however, of rather a remarkable character, which seems to traverse the whole county from east to west, from Hindhope at the top of the Kale, to Whitslaid on the Ale, in Selkirkshire, extending also into this county; and, on the other hand, it is said, to the sea shore, near the mouth of the Coquet, in Northumberland. We have not been able to trace it continuously, even in this county, but have seen it at various intermediate points, as in the burn above Edger-

* The geologist, especially in collecting specimens, has often occasion to observe thisdi fference of structure in rocks, which we have never seen properly explained. One naturally breaks into thin flat pieces, the other only into irregular, roundish, and angular fragments. It is the same structure that appears in the porphyry during decomposition as formerly noticed.

ton, in the porphyry; at Rink, where it is quarried, and on the Jed, in the greywacke; in a small stream (not in the map) east of Falside, and at Hallrule Mill, in the red sandstone; and south-east of Kirkton Church, and at Millar's Know, near Hawick, again in greywacke. It is often named the "Yetlin-rock," and consists of a dark greenstone, not very compact, and containing round nodules of calcspar. It is all more or less magnetic, sometimes, particularly at Kirkton, affecting the needle very considerably. The most remarkable circumstance connected with this vein is its almost rectilinear direction, and the great variety of formations it traverses—the greywacke, red sandstone, porphyry, and perhaps trap, in this county, and beyond the border, it would appear, also the coal formation.

Having now finished our description of the various individual rock formations found in Roxburghshire, we proceed to notice some of the more interesting points, where their relation to each other appears. The fundamental and oldest rock is undoubtedly the greywacke, which probably—for it contains no fossils whereby to determine this point, though the imperfect remains found in it shew that organized beings were not altogether awanting—belongs to the older Silurian series. Prior to the deposition both of the eastern and western sandstones, this rock had been raised into its present highly inclined position, both formations resting on it unconformably. Though we have seen no absolutely decisive evidence of this in regard to the Liddlesdale sandstones, yet no doubt of the fact can be entertained. On the various streams that cross the line of junction, as the Liddle and Hermitage, with their tributaries, the two formations are seen almost in contact, each preserving its characteristic inclination. No one who has examined the hills east of Langholm, where the sandstone, nearly horizontal, forms the top, and the greywacke, nearly vertical, the bottom, can have any hesitation in regard to their relative position and unconformability. Though some very high angles occur among the Liddlesdale sandstones, yet these cannot be ascribed to the influence of the greywacke, in regard to which its inclination is not more than may be accounted for by deposition on an uneven surface. Where the sandstone, as in the country west of Castleton, and also in the Carter, crops out abruptly on the top of a hill, either an immense denudation must be supposed, or a great change in position. In the former, the greywacke and sandstone seem both to have been elevated together; in the latter, this does not appear to be the case.

The relation of the Teviotdale red sandstone to the greywacke is more distinctly seen. One of the most interesting sections is in the immediate vicinity of Jedburgh, and is well known from the account given of it by Dr Hutton, since whose time it appears

considerably changed in appearance.* Close to the town the Jed has cut entirely through the red sandstone, and exposed the ends of the greywacke strata on which it rests. Below the bridge the transition beds are seen on the river, dipping at 45° S., whilst the red sandstone forms the bank above. Further up, a coarse hard conglomerate, consisting mostly of quartz, hornstone, and hardened clayslate, forms the bed of the river, and dips apparently at a high angle to the south-west, but is much broken and very irregular, and soon passes into the usual soft, red, clayey sandstone. At the mill about a quarter of a mile above the town, the road is cut out of a steep bank close to the river. At the side of the road, in the bank, there is a fine display of the red sandstone beds, cropping out in a long gentle curve, and dipping slightly into the hill. The bed of the river is greywacke and slate, in curiously irregular beds, but, on the whole, nearly vertical, and with their usual east and west direction. They rise eight or ten feet up the bank, and are then covered by the red sandstone, which is seen in a few places, though the junction is mostly concealed by the trees and brushwood, which seem to have grown up since Hutton made his drawing of this section. The bed resting immediately on the transition rocks is a greywacke breccia, in a basis of carbonate of iron and calcspar, probably deposited from springs. A similar breccia forms a vein in one of the slips in the greywacke strata, with which it seems more intimately connected than with the red sandstone.† It varies in depth with the irregularities of the surface on which it rests, but seems thinner now than in the time of Hutton. It is covered immediately by the red sandstone already sufficiently described.

Above this the red sandstone forms the bed of the river, and continues without interruption to beyond Kersheugh, where a ledge of greywacke again crosses the stream from east to west, dipping at 60° due south by compass. The strata, of the usual light grey colour, sometimes passing into red, are very regular, though somewhat broken. They rise pretty high on both sides, forming a ridge by which the breadth of the valley is much diminished, and through which the river seems to have cut a passage. Above, the valley widens out, and the red sandstone is seen dipping at 25° N. At first sight, this place resembles a lake, emptied of its waters by the gradual erosion of the grey-

* The drawing which Hutton published in his "Theory of the Earth" of this section is well known, having reappeared in many popular works, and is a good representation of what we may suppose it to be when fully exposed. Its present aspect, in those places where the sandstone is seen resting on the greywacke, is given as exactly as possible in Figs. 3 and 4, Plate I.

† It is marked *a*, in Fig. 1, Plate I.

wacke barrier by which they were confined. It is, however, more probable that the widening of the valley above and its contraction here are merely the result of the action of the river and elements on rocks of different hardness and resisting power. Where its banks were soft, the river has worn out for itself a wide channel; where they were hard, its action has been confined within narrower limits.

On the Rule there are no sections of much interest, and though in the burn west of Ruberslaw the greywacke and sandstone are seen in contact, the phenomena are nowise remarkable. Where the boundary line crosses the Teviot, some interesting sections occur, but we shall only notice one on the small stream near Hassendean, which differs a little from the others.* At this place the greywacke and slate dipping 80° to 90° towards S. 25° E. from the bed of the burn. The sides of this on the other hand are red sandstone of the usual character, which is quarried a little farther down, its dip being 5° N. 20° W. The lower bed of the sandstone is here also a very hard conglomerate, or rather breccia, in which the ends of the inferior strata, slightly turned over, are so involved, that specimens may be detached containing both rocks united; thus presenting, as it were, a miniature representation of the whole section.

These facts determine the age and position of the sandstone formations relatively to the greywacke, and prove that both the former are subsequent to the period of its elevation. The geological epoch of the Liddlesdale sandstone is also sufficiently determined by their connexion with the English and Drumfriesshire coal measures. This is not the case with the Teviotdale rocks, whose age is thus very doubtful, so that some have placed them in the *old*, others in the *new*, red sandstone formation. Had there been any point where it occurred in contact with the coal deposits, either in the east or west of this county, this problem might have been easily resolved. But we have sought in vain for any such, the trap appearing everywhere to interpose between them on the east, as the greywacke does on the west. It only remains for us, therefore, to describe the relations of these rocks to the igneous formations, and to consider whether this communicates any additional data. Even should this not be the case, the phenomena themselves are not without interest.

The relations of the trap to the stratified rocks has already been noticed, and is involved in no uncertainty. It may be seen overlying them in many places, and the red sandstone in particular, on the Tweed near Makerston, on the Teviot near Heiton, and on the Ale at Ancrum, this being indeed its usual position.

* See Fig. 8, Plate III.

In Southdean Hill there is a very interesting section, shewing the relation of the trap both to the red sandstone and the greywacke.* The top of the hill consists of the common dark greenstone, below which the red sandstone, in nearly horizontal beds, is seen cropping out all round the base of the hill, from the foot of the Carter Burn to below the manse; whilst in the bed of the Jed the greywack is alone seen, in nearly vertical strata, and composes the whole low country on the west. Southdean Hill is connected with the Carter by a low flat ridge composed of greywacke, partly covered by sandstone, and we are almost inclined to regard the trap on its top as the remnant of a large stream, or coulée, that has flowed down from the latter, and which, though partially worn away in subsequent revolutions, has, nevertheless, protected the inferior formations.

In Minto Hills we have a structure exactly similar, the vertical greywacke being covered by sandstone, lying, however, in a more inclined position than in the former hill, and more evidently broken up and altered by the trap, which forms the summit of the hills. These facts shew clearly that the trap is subsequent in its formation both to the red sandstone and greywacke; and its position, in reference to the coal deposits in the Carter† and Windburgh, shews that this is also the case in reference to these. It can thus furnish no term of comparison by which to determine their relative age.

The relations of the Cheviot porphyries to the sandstone formations is more uncertain. They only approach the coal sandstone in the upper part of Jedburgh parish, where they form its boundary on the north. The strata which compose the hills to the south and crop out on their acclivity, are separated by a hollow from the porphyry hills on the north, above which they seem to rise, dipping from them towards Northumberland. The sandstone, however, is not seen resting on the porphyry, and though its elevation may be ascribed to this, yet another explanation is not merely possible, but even the more probable. The trap which forms the summit of the Carter may have been the agent employed to raise the sandstone, which, indeed, seems rather to be placed side by side with the porphyry than to rest on it.‡

In a few places, however, there can be no doubt that the porphyry rests on, or has altered, certain sandstone rocks, to which

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* Fig. 9, Plate III. is an ideal section of this hill, *t t* being the trap, and *r s* the red sandstone, and *g g* the greywacke and clayslate.

† In Fig. 10, Plate III. the hill on the left of the section shews what we conceive is the true structure of this hill.

‡ The section, Fig. 10, represents what we consider the true relations of the coal sandstone to the trap and porphyry, and also of the various stratified deposits to each other.

therefore it must be posterior. One of these is near Broombanks, south of Edgerton, where it is found overlying a red conglomerate, which is in consequence much hardened. This conglomerate more resembles that of the red sandstone than any rock connected with the coal formation, and, we conceive, properly belongs to this, though it is impossible to decide with certainty. Another place is in the hills between Newbigging and Swinside, on the Oxnam Water, where sandstone beds are found interposed between the porphyry and greywacke. Near Townfoot,* in the burn, the sandstone is seen of an ochrey-yellow colour, soft and decomposed, dipping at 30° to S. 30° W., as if below the porphyry, with which, however, it is not seen in contact. The greywacke and clayslate are somewhat confused, part dipping at 45° in the same direction with the sandstone, and part at 80° to S. 10° E., the latter being by far the most common, and the other apparently accidental, but is nearer to the sandstone. In a quarry farther west, on a hill above Newbigging,† a few beds of hardened sandstone, of a yellowish-white colour, stained with dark blotches of reddish-brown, are found between the porphyry and clayslate, and may be traced along the hillside towards the former, with which we have no doubt they are connected. The sandstone is, however, too much altered by its proximity to the porphyry to enable us to decide on its true age; but we consider it more probable that it belongs to the Teviotdale sandstones than to the southern coal formation, whose relation to the igneous rocks it therefore leaves undetermined.

In regard to the small patch of sandstone found on the top of the hill near Frogden, north of Linton, there can be no doubt of its connexion with the Teviotdale formation. It also seems to have been raised up, and consequently to be older than the igneous rock on which it rests; but even this is uncertain, since both may have been elevated together. Besides, the porphyry here is much intermixed with trap, and consists of the dark-green calcareous rock formerly described, which, whatever may be its true character, appears to be one of the most recent in the porphyry formation, so that the relation of the red sandstone to the great mass of this rock still remains a matter of conjecture. The only fact established is, that part at least of the porphyry is newer than certain sandstone rocks, probably belonging to the Teviotdale formation, but the true epoch of this remains involved in uncertainty.

This is indeed the most doubtful question connected with the geology of Roxburghshire, though it is one rather of curiosity than of practical importance. The Teviotdale deposits have

* See Fig. 11, Plate III. † See Fig. 12, Plate III.

usually been considered as the old red sandstone, but, of late, many are disposed to regard them as the new.* In many respects they more closely resemble the latter, especially in the large proportion of thin, marly, and arenaceous strata. But mere similarity of mineralogical character is no proof of the identity of formations, having in most cases been determined by local circumstances. It seems generally to be taken for granted, from the mere colour of the rocks, that they must belong either to the old or new red sandstone, and that, when they are shewn not to be the one, they must of course be the other. This, however, by no means follows, red sandstones being found in almost all formations, and much of that in this being of a white colour. Another argument for their being the new red sandstone is taken from their supposed union with the English deposits; but this, as we have seen, is not the case. The only other proof is equally undecisive, or rather, has an opposite tendency. At Hunthill, near Jedburgh, several trials for coal, the last in 1798, have been made, but all without success. In these, beds of grey sandstone with impressions of plants, and also some thin seams of coal, are said to have been found, and on these beds the red sandstone is said to rest. The knowledge of formations and of fossil geology was, however, too imperfect then, and the desire of finding coal too strong, to permit us to place much dependance on these reports. In the Jed, the whole formation is cut through, with no indications of coal below, and it is probable that the rocks at Hunthill either belong to the red sandstone, or, if independent, are higher in the series. In either case they leave the question of its age untouched; and as, with this exception, no fossils have ever been found in these rocks, there seems to be an utter want of all decisive evidence on this point.†

There are, however, some facts which give probability to the opinion that these rocks belong to the epoch of the old red sandstone. The greywacke strata in the whole south of Scotland are distinguished by their high inclination and uniform direction, nearly in the line of east and west by compass. This remarkable regularity shews that the cause of elevation, whatever may have been its nature, has been general, influencing the whole chain of

* Dr M'Culloch's opinion seems to have changed in the opposite direction. In his account of Scotland, in the Edinburgh Encyclopedia, (vol. xvii. p. 625,) published in 1826, he classes them with the red marls of England,; whereas in the memoir which accompanies his Geological Map, (p. 56,) he affirms that this rock is not found in Scotland. In other parts, however, he admits of some exceptions.

† Since the above was written, we have seen a notice, in the public prints, of some remains of fishes, belonging to the upper part of the old red sandstone, having been found in a wall near Jedburgh. The stone is supposed to have been taken from Tudhope quarry, in the immediate vicinity. Should this be confirmed, it will set the question of the age of these rocks completely at rest.

mountains, from St Abb's Head to the west coast of Galloway. Now, many facts prove that this elevation took place previous to the period of the deposition of the old red sandstone, and, therefore, if it was immediately followed by the formation of the Teviotdale sandstones, these must coincide with that deposit. But there is no ground for supposing that one part of the greywacke has, since its elevation, changed its level in any considerable degree relatively to another, or that the vale of the Teviot was dry land when the sandstones of Liddlesdale and Berwickshire, both below the coal, were deposited in a deep ocean. It seems highly improbable that, during the long period this occupied, no strata should have been formed in the basin of the Teviot, which must have been part of the bed or coast of the same sea. Neither can we conceive these beds subsequently removed by denudation, and others deposited in their place, without the destruction at the same time of the irregularities in the surface of the greywacke on which they were deposited. The points and ridges of the transition rocks rising up at Jedburgh, Kersheugh, and, we suspect, also in various parts of the valley of the Teviot, must have either been destroyed themselves, or have preserved the strata deposited among them. Besides, were we to suppose the basin of the Teviot to have continued dry land during the deposition of these neighbouring formations, it is very difficult to account for the phenomena it presents. During all that long period, the projecting jagged points of the greywacke must have been exposed to degradation; the rock must have been weathered and worn down, its debris deposited in the crevices below, and, unless we can suppose a world existing for ages without life, which is also refuted by the contemporary coal deposits, vegetable mould accumulated. Yet such formations are nowhere found: we see no beds of vegetable soil covering the greywacke; no vast heaps of its debris, like those on the sides of its present mountains, filling its hollows; no old river channels, the former drains of its superabundant moisture, now occupied by red sandstone. Everything indicates that the transition strata were hardly upraised till the deposition of the sandstone began. The thin masses of breccia, in the under part of the formation, are not more in amount than the simple elevation of the strata would produce; whilst the freshness of the smallest fragments proves that they were not long exposed to the action of the elements, but soon preserved in that state, by their consolidation into a new rock. These considerations induce us to prefer the opinion that the under part at least of these beds belong to the old red sandstone, and, if not older, contemporary with the Liddlesdale rocks.

But how then shall we account for the different character of

these two formations, supposing them synchronous? Why are the rocks in the west, white sandstones, not devoid of fossils—those on the east, red sandstones, unfossiliferous, and so often almost mere marls or clay? In the first place, these distinctions are not absolutely characteristic. red sandstones occur in the west, though rarely, and white ones in the east. Again, though synchronous, the deposits seem always to have been separated from each other, and produced under different conditions. The Teviotdale sandstones lie at present in a bay of the greywacke, and, we imagine, have at all times done so. Even the present courses of the rivers seem then to have existed; for the conglomerates are more abundant where the Teviot, Ale. and Tweed enter the formation, than in other parts of it at a distance from these rivers. The greywacke barrier on the south appears also to have been more extensive, being now partly covered by the porphyry—partly, we suspect, converted into that rock. This distinction of the basins would permit the formations in them to assume independent local characters. Now it is remarkable that the Liddlesdale sandstones, which lie on the outskirts of the greywacke, and were probably formed on an open sea or on its coast, should be a mere continuation of the English formations, with few if any local peculiarities; whereas the Teviotdale, which occupy a basin enclosed in the greywacke, and which, we suppose, were formed in a gulf, should have very peculiar local characters, perfectly consistent with this supposition. The strata, we have seen, though thin, are regular, and their composition very uniform, both pointing to an enclosed place of deposition, little affected by tides or currents, and not exposed to violent tempests. Hence, even the ripple-marks on the surface of the beds are small and by no means very common. The connexion of red sandstones with the eruption of porphyry rocks has long been recognised, and, in this case, is fully confirmed. The Cheviot porphyries were then probably in the course of formation, and from this igneous action a large portion of the materials of the strata were derived, especially the felspar and lime, composing the base, and the ferruginous matter by which they are so generally coloured. In waters impregnated with such substances, and also with the noxious gases consequent on volcanic activity, organized beings, whether animal or vegetable, cannot be supposed to have existed; and the entire absence of fossil remains, at least in the larger portion of the formation, with the rarity of limestone rocks, generally the result or accompaniment of animated existence, is thus accounted for. The formation, too, in many places, has more the aspect of a tertiary than a secondary deposit, and with this the circumstances in which we suppose it to have been formed fully agree. Our theory regarding

these rocks therefore is, that they compose an independent local formation, commencing in the period of the old red sandstone, but not improbably, since deposition would proceed very slowly, continued into the carboniferous epoch. The white sandstones, which become more common above, and form thick beds with the partial appearance of fossils, indicate a cessation of igneous activity and a more intimate connexion with the ocean. They would also thus shew an approach to the coal formation, to which the strata found at Hunthill and also at Caverton Edge would belong, lying, however, above and not below the red sandstones. The limestone also, found above Bedrule, might, in this way, belong to the same period.

The chief interest of this question arises from its connexion with the more important practical problem of the probability of finding workable coal in this district. Were the rocks the new sandstones, there would be no improbability in supposing that they might cover coal, deposited in some hollow of the greywacke and never yet discovered. Were they superior to the English carboniferous formations, the latter might extend up this valley, and, though existing at no great depth, be yet wholly concealed below the horizontal beds of the red sandstone. If these rocks, on the other hand, are the old red, the hopes of valuable coal almost vanish. None need be looked for below them, and it is very improbable that any should exist above undiscovered. It has been supposed that the coal at Hunthill has been partially excavated; but had workable coal ever been found there, the value of the mines would have prevented their being lightly abandoned, so that the best proof that none exists is, that none is wrought. Were we disposed to look for coal in this county, it would be below the greenstone cappings of the hills, especially those to the east of Penielheugh, where the coal formation, had it ever existed, is most likely to have been preserved from the effects of denudation. These rocks are more likely to have concealed such a real treasure than the alluvial deposits, notwithstanding the immense thickness of these in many places. Nor is there aught improbable in valuable coal being found below trap, as many examples, both in our own and other countries, shew. All things considered, it is, however, very unlikely that any beds of coal, that would repay the working, will ever be discovered in this district.

Leaving these doubtful questions, we shall now state what we conceive to be the true order and connexion of geological changes in this county, so far as they have been determined by the preceding investigations. The earliest of these has been the deposition, consolidation, and elevation of the greywacke and clayslate, with the eruption of the igneous rocks contained in them, though their fragmentary structure proves that they have

not been the first in the series. In consequence of its elevation, the surface occupied by this rock seems to have been distinguished by inequalities similar in many respects to those now found on it, but probably of far greater dimensions. Besides the portion of the great central greywacke chain in the north-west, a smaller range of this rock ran parallel to it on the east, the two being joined by the high ground between Hawick and the head of the Rule. As just now stated, the western slope of the greywacke was an open sea, connected with the English coal basins; whilst on the east a deep gulph existed, gradually filling with other deposits. The Cheviot porphyries were, at the same time, rising to the surface, covering in part the southern chain of greywacke, in part converting it into porphyry, and furnishing materials for the sandstone formation on the north. Then, it would appear, the country sunk deeper into the ocean, the igneous action in the Cheviots became less violent, and the white sandstone, with the first approximation to the coal measure, spread over the red sandstone district. The trap rocks next forced their way among the sandstones in both formations, or, escaping through rents, spread out in wide beds on the bottom of the sea. The surface had now acquired its present leading features, when the whole country begins to rise above the waters. This would occasion currents and denudation, which would be much increased when the hills on the north and south began to form islands with a strait between, like the Pentland Firth or the English Channel. It is not difficult to anticipate what would be the consequences of this condition of things, unless the present physical relations of the globe were completely altered. In deep water, in the open sea, the general direction of the currents is from the poles to the equator; and it is curious to observe that many facts connected with the greywacke, which on other accounts we have reason to believe is a deep sea or pelagic deposit, prove that this was the case during its formation, and that the materials composing it were conveyed from the north. Superficial currents, on the other hand, like those on our present coasts, flow rather from west to east, the direction which the alluvial drift can be shewn to have followed. This is an important fact, establishing the constancy of the laws which have regulated cosmical phenomena in all geological periods, and we shall now state the evidence by which it is confirmed.

The alluvium in this county, as in most of the south of Scotland, forms three divisions, distinguished chiefly by their different hardness and consistency. These are the old boulder clay, the firmest and most tenacious of the whole; a newer boulder clay, of a looser texture and lighter colour than the former; and, third, an arenaceous deposit of sands and gravel. In many parts of

Roxburghshire it is, however, impossible to distinguish these, especially the last two, from each other, and the deposit has often a mere local character. The first consists of numerous boulders of various sizes, embedded in a tough red clay. This is most distinctly seen in the north of the county, especially on the Leader, where it fills all the low ground. The boulders here are almost entirely greywacke and felspar porphyry, or the transition rocks on the west. In general it is unstratified, and forms high scaurs along the river. Near Birkhillside, but not in this county, it contains some small layers of pretty hard stratified sand. It is well seen along the road on the east or Berwickshire side of the Leader, and also in the bed of that stream, especially at the bridge. Here some of it much resembles the old conglomerate, but though very tenacious, is not nearly so hard, and decomposes readily. Part of it above this consists of boulders of clayslate and greywacke, in a basis of grey sand, probably the finer detritus.

In other parts of the county the same formation occurs, though, we think, less abundantly, and more united with the other divisions. These are looser and less compact, and seem in general to be derived from the formations in the vicinity. Immense masses of this kind passing below into the former are found on the east side of the Eildons from St Boswell's round to Melrose, and are well seen on the banks of the Tweed, and of the various streams that enter it between these two places. It is also very thickly distributed on the north bank of the Tweed below Kelso, in Ednam parish, where the upper part is very loose and gravelly, belonging to the third division. Near Kaimflat it forms several round hills and knolls, probably indicating the action of water, though susceptible of another explanation. In the valley of the Teviot it is also very thickly distributed, especially near the foot of the Ale, where it is very deeply cut by this river, which winds round a rising ground formed of it on its way to join the Teviot. Similar deposits are also seen in great abundance on the Kale near Morebattle, and the valley below is filled with the most recent alluvial formations, concealing the inferior rocks.

In these upper deposits, the principal distinction of those in different localities is in colour, which seems plainly to depend on the rocks whence they are derived. The decomposing greywacke forms a light grey or yellowish red clay, moderately stiff, very retentive of moisture, and, consequently, wet and cold. The red sandstone is converted into a very deep red sand, the colour and coherence varying a little with the amount of clay in the rock. Over the Kelso coal formation the soil is white and firm, but, from the intermixture of calcareous matter, fertile. In Liddlesdale, the

alluvium in the low ground seems derived principally from the greywacke, but the hills are covered by a poor thin sand, of a light red or white colour. Where trap rocks prevail, the soil is brownish red, or of a colour and consistency intermediate between the greywacke and red sandstone. The porphyry also forms a red soil, sometimes, as above Oxnam, brighter in the colour than any of the former. It seems also to impart this colour to the greywacke, as, for instance, on the south-west side of the Eildons, where it is very deep red. All these varieties are, however, easier recognised in nature than distinguished in description, and often furnish valuable indications of the character of the inferior rocks. In one respect, however, they have a tendency to mislead, all of them appearing redder at a distance than near at hand, except the sandstone and some parts of the porphyry. This is remarkably the case with the greywacke even in cases where it is not affected by igneous rocks.

These distinctions are of considerable importance in determining the direction of the currents in this county. The boulders in the alluvium are mostly of rocks found in the immediate vicinity, and therefore furnish but little evidence how these have flowed. We have observed no fragments of primary* or other rocks which could be referred to distant localities. Greywacke boulders are, however, found in considerable abundance far to the east of the present limits of that formation, and quite beyond the reach of the present rivers. Its peculiar coloured soil also spreads over the red sandstone considerably east of the limit. The latter, in its turn, encroaches with its debris into the trap district on the east, but never into the greywacke on the west. The same has happened to the porphyry and eastern coal formation, though, from their position on the margin of the county, it is less seen within its limits. In the valley of the Liddle the alluvium contains much greywacke, but, in the high sandstone country, it is almost entirely of this rock, with a few fragments of trap. Sandstone detritus is common in the low country west of its outcrop on the southern border of the county, as is remarkably well seen round the base of Southdean Hill, where the pure white of the coal sandstone contrasts singularly with the dark red of that in the hill. Boulders of trap appear to have been conveyed eastward in no less abundance than the former, but the nature of this rock renders the evidence from it less decisive. It often appears in veins where least expected, and often, where only fragments are seen on the surface, it appears to form a solid mass

* The granite boulders occurring in the lower part of Liddlesdale form no exception, having probably been derived from Criffel and other granite mountains in Kirkcudbright, about thirty-five miles distant on the west, and thus confirming the remarks in the text.

below. This, we conceive, is the case in Ancrum Moor, which is covered by a slight-coloured soil of decomposed trap, mingled with innumerable blocks of dark greenstone, often of immense size and very irregular forms. No rocks certainly fixed appear on the surface, though some of the masses more resemble this than loose stones, so that we are still in doubt whether they belong to a solid bed below, or are merely a result of detrital action. Their immense number inclines us to the former opinion, since, if only those visible were collected, they would form a mountain far exceeding in magnitude any now existing in this quarter.

Another class of phenomena, proving diluvial action, are the effects of denudation, seen both on the hills and rock formations. Round Hawick, and further west, the transition hills are small and rounded, often forming long ridges with the same direction as the strata, and plainly a result of the harder beds having been preserved whilst the softer were worn away. This has not resulted from the action of the weather, as is shewn by the form of the hills, and more especially by the removal of the detritus. This is not accumulated round their base, but swept away and scattered over the country to the east. The red sandstone has suffered still more from this cause. The patch of hardened conglomerate found below the porphyry at Broombanks plainly shews that this rock has formerly extended at least thus far. The porphyry, by hardening the rock and preserving it from the effects of the currents, has enabled this fragment to remain a memorial of its former extent, and the destruction it has undergone in other places. The trap has had a like effect, as is seen in Southdean Hill, where the sandstone protrudes considerably beyond its regular limits. Even where the trap has been removed, the sandstone, as on the south-east side of this hill, has remained, the upper bed, though harder, having, of course, suffered most. The trap in Ruberslaw has also preserved the sandstone, though in a different manner. Here it does not overly, but rises like a vein through the strata, which are found all round it, having been preserved by the greater consistency they have acquired, and also by the trap forming the most prominent and exposed part of the hill, and thus breaking the force of the currents. On the top of this hill we found some angular fragments of the red sandstone, but with nothing to determine how they had come into this position. The Minto Hills seem to belong to a kind of intermediate class—the tufa—partly overlying, partly raising up and hardening, the sandstone, in both ways preserving it as a memorial of the destruction effected in other parts of the formation where it was not thus protected.

The trap hills furnish other proofs of these facts. Their most

precipitant side is most frequently to the west; it is on it that the rocks are seen cropping out, and that their true relations appear; whereas on the east everything is hid under a vast mass of detritus. These precipices, fronting to the west, are well seen in Minto and Ancrum Craigs and in some of the hills behind Mount Teviot, but, in some instances, are the mere result of the cropping out of the trap bed, which is inclined to the east. This, however, does not account for the alluvium being chiefly accumulated on the opposite side, and which thus furnishes unequivocal evidence of the direction in which the currents have flowed. The vast heaps of debris east of the Eildons is one of the best examples of this we have seen, but the same thing may be observed in Ednam parish, and also behind Penielheugh, Lanton Hill, and the Minto Hills. Ruberslaw has acted in the same way, but, perhaps, more conspicuously in preserving the sandstone of Denholm Hill. Facts of this nature are, however, too common all over the centre and south of Scotland to detain us longer, and it is sufficient to have noticed their occurrence. We have sometimes thought that a coincidence might be traced between the hollows or passes in the western hills and the denudation of the rocks in the east, and also with the distribution of the alluvium. Such generalizations, however, would require a more extended series of observations than we have had an opportunity of making, and a more correct representation of the natural features of the county than is to be found in our present maps.

There are a few other isolated facts which may be mentioned as confirming these conclusions. In the hollow near Mossend, between Dunslaw and Penielheugh, is a formation of sand shewing the former presence of water at this elevation. It is of a white colour, and, though exposed to a depth of five or six feet, shews no marks of stratification. A similar formation is common in the hollows of the hills north of Yetholm, as near Graden, where it has been dug to a considerable depth, and is of a red colour and mixed with earth, like that formed from the decomposition of the red sandstone. It is thus a proof both of the destruction of this rock, and also of the transport of the materials derived from it to the east. Similar deposits of sand occur in the hollow east of Smailholm Tower, probably connected with the masses of alluvium seen on the banks of the Tweed above Makerston.

These facts, to which many similar ones might be added, sufficiently prove the former passage of currents of water over this county, and also that they have followed the direction which theory supposes. There is, however, another class of causes to which some of these appearances have lately been ascribed, which may require a short notice. We allude to the glacier

theory recently brought forward by Professor Agassiz, to explain the transport of boulders and the formation of alluvial mounds. The proofs of the former existence of glaciers in Scotland, seen on the rocks of Salisbury Craigs, Corstorphine Hill, and the sandstone at Craigleith, and especially the polished surfaces of the clinkstone, in the gorge between Braid and Blackford Hills, seem perfectly decisive. We had hoped to find similar phenomena in Roxburghshire, but have not been altogether successful. The trap hills have been examined in vain for those grooved and polished surfaces, so well seen in the localities above referred to. Their absence from the sandstone, considering its soft friable nature, is not surprising; but the trap is better adapted both to receive and preserve these impressions. The only place where marks which might be ascribed to this cause were seen, was on the greenstone hills, near Smailholm Tower. The rock here was in some places grooved, and in others had rounded polished surfaces, not unlike those of Corstorphine Hill. But the grooves had no constant or even prevailing direction, being apparently determined by the natural joints of the rock; and the smooth surfaces were seen to be continued below the decomposing crusts of the solid trap, so that they could not be ascribed to an extraneous cause. Both seem too evidently connected with the structure of the stone, as affected by decomposition, to permit us to find here the evidence we were in quest of, and none of the other hills in the county offered more decisive proof. There are, however, a few facts of another kind, which may be thus explained. On the top of one of the rugged knolls near Smailholm Tower, we observed a large mass of hard grey sandstone, of a very irregular and angular form, so that it cannot be supposed to have been subjected to the action of running water, yet, from its position, evidently a travelled stone. On the greywacke hills north of Melrose, near the sources of the Allan Water, large angular blocks of felspar porphyry, similar to that found so abundantly in the transition mountains of Selkirkshire to the west, are not uncommon. The ground here, though high, is flat, and forms a kind of table land, extending back to the high summits round the head of Cadon Water, so that a glacier might readily convey these blocks from the one place to the other; whereas if rolled along the ground, they would have been interupted by the deep valley of the Galla. The mounds of alluvium round Ednam may have had a similar origin. In the valley of the Teviot, above Ancrum Bridge, several mounds of alluvium run parallel to the river on the south side, and may, without improbability, be regarded as the moraines of a glacier descending from Lanton Hill. On the north-east side of that hill also, near Monklaw, on the old road

to Jedburgh, some very large masses of basalt may be seen, one of which, now broken into two, has contained above two hundred cubic feet of stone, thus weighing about seventeen tons. Near this place, also, a great number of basalt boulders are lying, heaped up in a kind of wall across the burn, exactly as they might be supposed to have been deposited by a glacier. These are the most decisive proofs of this kind of action which we have met with in Roxburghshire ; but as most of them may have arisen from other causes, it would be improper to found any theory on them. It may also be stated that this theory seems to us, even if admitted in its fullest extent, by no means capable of explaining all the phenomena of the alluvial phenomena even of this county, and will not do away with the necessity of marine currents, or the proofs of the submersion of the present dry land beneath the ocean. It may be employed, as it was by Playfair, who originally proposed it, to explain the transport of erratic blocks, like those of the Alps and Jura ; but we can scarcely conceive of one who has seen the innumerable heaps of rounded boulders, derived from the primary rocks of Scandinavia, scattered over the plains of northern Germany, and found even in our own land, endeavouring to account for them in this manner. Marine currents, aided by floating ice, seems the only hypothesis adequate to explain the whole phenomena even of this country.

About two years ago, an account appeared in a popular journal, of natural terraces, similar to those of Glenroy, having been discovered on the Eildon and other surrounding hills. No less than fifteen or sixteen of these were said to exist, ranging from 1300 to about 500 feet above the sea, the average distance between each pair being fifty-four and a-half feet. These natural terraces, or beach-marks, as, from their supposed origin, they were named, though not all visible on any one hill, were yet said to be " clearly discernible, existing in a regular series." " All of these beach-marks," it is affirmed, " run in a perfectly horizontal line, are parallel to one another, and agree in level with corresponding members of the series on the adjoining hills." In some places they are stated to be 300 feet broad, in others only " a slight trace," yet always visible where the nature of the ground permitted. As proofs of the former submersion of this district, these terraces would have been highly interesting, and agreed well with the facts stated in the immediately preceding part of this essay ; but, after carefully examining these hills, we could not find any sufficient evidence for the existence of such beach-marks. The declivities of the Eildons, like those of most other hills, are indeed marked with numerous irregularities, and in several places shelves, pretty level, and of various dimensions, are found. But we have seen no shingle, or other evidences that these have

ever been sea-beaches; and, even from the discoverer's own account, their external appearance will be seen to be very unlike the roads of Glenroy. The most distinct of them are far from being horizontal, and, what is even more fatal, seem to inosculate into each other in various ways. Neither do they continue regular in breadth, even where no reasons to the contrary appears in the nature of the ground. Again, one, No. 10, in the descending series, has cut 300 feet into the hill in some places, and would thus, by the mere effects of degradation, have infallibly obliterated every trace of the nine above, which must have been first formed. It is impossible to conceive a terrace of this breadth, cut by water out of the side of hills, so highly inclined as the Eildons, without changing the whole surface of the ground above. Much weight is attached to the exact coincidence of elevation in the series of terraces, as traced on the various hills, where they are said to occur "always at parallel and corresponding levels." Now Galashiels is four miles distant from the Eildons, and some of the hills seem to have been even more remote than this town. But at four miles distance, fifty-five feet, the average height between the terraces, would not subtend an angle of 10°, not a third of that probably appreciable by the instrument, "a good pocket spirit level," and much less than we can suppose the error of observation to have been. Besides this, no notice is taken of any allowance having been made for the difference of the true from the apparent level, which, at four miles' distance, is above ten feet; and, at six miles, nearly twenty-four, or about half that between two of the terraces. Another circumstance, of which no notice is taken, is, that on the Eildons there are very distinct remains of a Roman encampment, supposed by some to be the Trimontium of Ptolemy, which occupies the place of a still more ancient British fortification. Now the most distinct terraces on the hills seem to us evidently connected with these remains, and others may have had a similar origin, yet, in the essay referred to, they are never mentioned, nor are we told how they are distinguished from the supposed beach-marks. We are, therefore, compelled to reject this supposed discovery, though not the conclusion to which it led. Proofs less striking indeed, but, to the geologist at least, no less valid, of the former submersion of these hills, exist in the rounded greywacke boulders which may be found high up on their sides. This is, however, only of consequence as shewing that they formed no exception to what has been proved to have been the general condition of the whole county.

In examining many of the high and prominent hills in Roxburghshire, we have been convinced that much care is necessary in assuming the apparent terraces on their sides to be the result

of aqueous action. Almost every one of them seems to have been used by the ancient inhabitants of the surrounding country either for religious purposes or as places of refuge in war. Remains of ditches and walls surrounding their summits are to be found on most of them, and often, as is the case on the Eildons, more than one series of these occur. On these hills they are particularly plain in the hollow joining the two highest peaks, this point having been supposed most liable to attack. On the hill at Broombanks, above Edgerton, they are very distinct, and, enclosing a large space, have probably been an encampment, or place for securing cattle. On Bonchester, and on Camp Hill, one of the Cheviots, near Yetholm, on the immediate border of England, they are also very plain, and apparently for similar purposes. On Ruberslaw they are not less evident, notwithstanding the rugged and uneven nature of the ground, but the space enclosed is small and inconvenient, and we should conjecture their purpose here to have been religious. This, however, is a digression from the proper subject of this essay, and we shall only observe that of these terraces some are truly natural. These, however, are seldom perfectly horizontal, and, on hills of stratified rocks, generally follow the outcrop of the beds or formations, the boundary of the red sandstone being in some cases thus marked. In igneous formations, like the Eildons, they have, on the other hand, been in general occasioned by one eruption rising through and partially overspreading the previous one, which thus surrounds it in a ledge of various breadth. This theory seems fully competent to account for all the phenomena of these terraces—their often great but varying breadth, and their apparent parallelism and horizontality.

The camp on the Eildons was connected with the Roman Causeway, which tranverses Roxburghshire from south-west to north-east. The part of it in Oxnam parish has suffered least from modern improvements, and is not merely interesting to the antiquary but also to the geologist. Nearly fifteen centuries have passed away since the mighty nation who formed it left our shores, and for more than that period it has remained without alteration or repair. Here, then, is what is often sought—a record of the change that fifteen centuries can effect on the surface of the ground, when the elements are neither aided nor retarded by human art. The result would probably satisfy neither of the two great rival schools of geologists. The causeway is in most places not merely entire and unbroken, but even covered by a bed of mould eight or ten inches thick. The partisans of the theory of stability might therefore ask, Where, then, is the proof of change and of the gradual destruction of the dry ground, which is at last to reduce the whole globe to the

level of the ocean? Instead of the earth wasting away, is it not here rather gaining in elevation? His opponent might, however, point him to those places where the smallest rivulet crosses the road, or even where water collects in a hollow. In all these the pavement is completely broken up and removed. Where it crosses the Oxnam Water still more unequivocal proofs of the wearing down of the land occur, the road now reaching the bank of the stream considerably above its present bed, which must consequently have been hollowed out. This causeway, therefore, forms a proof of the slowness of natural changes, of the protecting power of vegetation, and of the immense periods which must have been occupied by those alterations which are visible even on the present surface of the earth.

We should now have made some observations on the nature of the soils over the different rocks as connected with agriculture, but most of these have already found a place in previous parts of this essay. The detritus of the trap rocks is the most uniformly fertile, and even in the most unpromising places, as, for instance, in Ancrum Moor, when freed from stones and stagnant water, well repays the labour expended on it. The red sandstone also furnishes a not ungrateful soil, the rocks containing all the elements needed for fertility. Some of the coarse gritty sandstones form the only exception, but the bad qualities even of these are ameliorated by the trap rocks with which they are so generally associated; and the soil of the Nisbits, almost the granary of Roxburghshire, results from their combination. The porphyry also yields a rich and prolific soil, composed of alumina, quartz, and iron, in very favourable proportions. The greywacke is more unproductive, yet even in it, the clay and sand mutually temper each other, and the numerous calcspar veins furnish a proportion of lime, so that when freed from the superfluous moisture, it too repays the toil of cultivation. If the stigma of sterility attaches to any soil in this county, it is that resulting from the decomposition of the Liddlesdale sandstone, yet the most barren districts are beyond, or on the very outskirts of Roxburghshire, and the whole central valley only asks man to do his part to return him an abundant reward. In truth, no part of this county has reason to complain of the soil. Peat-moss is by no means common, except on some of the higher Cheviots, on the borders of Liddlesdale, and in the elevated country along the confines of Selkirkshire, as, in particular, in the lake-like hollow below Threipwood, near the sources of the Allan Water. Even the currents that have flowed over the county have added to its fertility by commingling all the various soils, bearing, for instance, the stiff clays of the transition hills to give consistency to the sands in the secondary valleys. The distance of coal and lime

are the great geological drawbacks on the central districts of Roxburgh; the mountains which formerly secured its independence now shutting it out from these productions of its richer neighbours on the south. Yet art, by improving the means of communication, may do much to remove these disadvantages. A thorough system of draining is, however, the greatest improvement that could be effected on the agriculture of this county, and that which has been least attended to in those parts, where most of all required by the soil and climate.

PROCEEDINGS OF THE AGRICULTURAL CHEMISTRY ASSOCIATION.

By Professor Johnston.

VI.—ON THE ECONOMICAL USE OF BONES AS A MANURE, AND ON THEIR SOLUTION IN SULPHURIC ACID.

The importance of artificial or portable manures, both to the practical farmer who has a profit to make by the cultivation of the soil, and to the community at large, who are fed by the produce he raises, is becoming every day more and more apparent. The importation of guano has been the means of creating a taste, as it were, among practical men for foreign manures, which will remain after the supply of guano has diminished. The place of guano, therefore, must be in some way or other supplied, and it is fortunate that, at this very time, the assistance of chemistry has been secured, by which alone this object can be efficiently and economically attained. I look upon the introduction and use of guano as only a step in the progress of agricultural improvement. It has taught the whole farming interest the great profit of a more liberal manuring of the land—has convinced them that what is to fertilize a field may be compressed into a comparatively small bulk—and has prepared them more willingly and more generally to receive those preparations and mixtures which chemistry will by-and-by be able to compound, with the view of meeting the wants of every soil and every crop. This perfect adaptation of manures to soils and crops will not be effected at once. Quackery will for a while beset the steps of the farmer, and defective knowledge, especially of practical agriculture and of physiology, will lead the chemist astray; but the result is sure to be attained at last. We must, in the mean time, have perfect faith in Science herself, while we, at the same time, exer-

cise a reasonable distrust towards those scientific men who profess to know all, and to be already able to explain everything.

Two points are of great national importance at the present moment.

1°. The home supply of manure is not sufficient to meet the wants of the land. Can we do nothing to husband that which we possess? Can we not apply it in such a way as to make the same quantity go further? We pay also large sums every year to foreign countries for manures; can we not make a smaller outlay serve our purpose, by applying what we import in a more economical manner?

2°. Again, guano is likely either to become scarce or to rise in price. Can we not bring some of our other well-known manures into such a form as shall enable us to use them in the same way as guano—as generally and at as cheap a rate—as shall enable them by their cheapness to supersede guano altogether?

These are grave national questions, and, I think, we are every day feeling more and more justified in answering them in the affirmative.

I shall illustrate this position in the present paper by a reference to the subject of bones.

It is forty or fifty years since bones began to be introduced in large quantities into this country from the Continent, and especially from the north of Europe. They have since been constantly growing in repute as a manure, and large tracts of our high lands have long been almost dependant upon them for the means of profitable cultivation. The vast importations of guano during the last two years have scarcely checked the demand for them, and there is no question, I think, that their use will hereafter receive a very large developement.

§ 1. *Composition of Bones.*

Bones differ slightly in composition in different animals. They vary also with the age of the animal and with the part of the body from which they are taken. The following composition of the bones of the cow will represent very nearly that of the bones which are usually applied to the land :—

Organic Animal Matter (gelatine,)	33¼
Phosphate of Lime, ...	55¼
Phosphate of Magnesia, ...	3
Carbonate of Lime, ...	3¾
Soda and Common Salt, ...	3½
Chloride of Calcium, ...	1
	100

When bones are burned in the open fire, the animal matter they contain—the gelatine—disappears, and the white *bone earth* alone remains. These two portions of the bone, the combustible

or organic, and the incombustible or inorganic part, are equally essential to the fertilizing action which the bones produce. As some inexperienced writers have disputed this in regard to the organic part, it will be proper briefly to advert to the composition and mode of action of this portion of the bone.

§ 2. *Composition and mode of Action of the Organic part of Bones.*

The gelatine of bones consists of

Carbon, ...	50 37
Hydrogen, ...	6 33
Nitrogen, ...	17.95
Oxygen, ...	25.35
	100.

It is identical in composition with horn and with isinglass, and is very nearly the same as hair, wool, and skin. It is of importance to recollect that it contains about 18 per cent., or one-sixth of its whole weight, of nitrogen.

That this organic part is *likely* to act beneficially as a manure, is rendered probable by the fact that horn shavings are highly valued as an application to the land, and that the parings of hides and woollen rags bring a high price in the market as manures for certain crops.

But that it *does* act beneficially is proved by the success which attends its use when separated from the earthy part of the bones. In Manchester, bones are boiled for the extraction of a size (glue) which is used in the stiffening of calicoes. When the stiffening liquor is so far exhausted as to be unfit for further use, it has been applied as a liquid manure to grass-lands with the greatest success. There can be no reasonable question then that upon the organic part of bones their beneficial action, as a manure, in some degree depends. It is only surprising that chemists of name should have been found to deny it, and that practical men should have so far distrusted their own experience as to have believed and acted upon such an opinion.

But how does this organic matter act? It, no doubt, feeds the plant, but it may do this in one or other of two ways. It may either be completely decomposed in the soil and enter the roots of plants—as Liebig supposes all organic nourishment to enter—in the form of carbonic acid and ammonia; or it may be rendered soluble in the soil, and may thus be taken up by the roots, without undergoing any ultimate and thorough decomposition.

Now, supposing it to be resolved into carbonic acid and ammonia, the quantity of gelatine contained in 100 lbs. of dry bone is sufficient to produce upwards of 6½ lbs. of ammonia—as

much as is present in 20 lbs. of sal-ammoniac, or in 30 lbs. of crystallized sulphate of ammonia. Supposing the animal matter of the bones to be thus decomposed in the soil before it can be useful to the plant, few, I think, will question that the quantity of ammonia it is likely to produce would materially aid the growth of the crops to which the bones are applied.

But I do not think this final decomposition necessary. The large quantity of nitrogen which the gelatine contains may, I believe, be taken up by the plant without being previously brought into the state of ammonia. The gelatine, being rendered soluble in the soil, may enter the roots, and may at once minister to the growth of the plant, just as the gluten of the seed, being rendered soluble when the grain germinates, ascends with the sap, and feeds the young plant. It would be out of place here to discuss this point, or to give tho reasons which induce me to entertain this opinion. It is sufficient for the practical man to know that whichever of these views a man may hold, he must still grant that the gelatine of the bone is valuable to the farmer. Whether its nitrogen enters into the root in the form of ammonia, or in some more compound state, it must be useful to the plant: and, therefore, he who advises the farmer to burn his bones, or would persuade him that the earthy part alone, or *anything equivalent to this earthy part* would alone be as useful to his land as the entire bone, advises him to his hurt, and would persuade him to that which would eventually be a source of loss.

§ 3. *Mode of Action of the Inorganic part of Bones.*

The composition of the incombustible part of bones, the bone earth, has been given above. It consists chiefly of phosphate of lime, with about 3 per cent. each of phosphate of magnesia, carbonate of lime, and salts of soda.

All these substances, of which its bones consist, the ox must have derived from its vegetable food. They must, therefore, exist in all nutritive plants. But these plants can obtain them only from the soil. They must, therefore, be present in all fertile soils. And if a soil is poor in these substances, or is wholly void of them, that soil must be improved by the addition of these things. In other words, they must be invaluable as manures to such a soil: and hence the worth of bones, and other manures which contain these substances, to the practical farmer.

Sprengel long ago reasoned thus; and he asserted that the indications of theory were proved by experience—that burned bones actually fertilized the land.

Liebig followed him; but more boldly pronounced that the whole value of bones, as a manure, depended upon, and was derived from, the earthy phosphates they contained.

In the Appendix to my published *Lectures on Agricultural Chemistry and Geology*, and in my *Suggestions for Experiments in Practical Agriculture* published separately, I suggested, with the view of settling this question to the satisfaction of all, that comparative experiments should be made with burned and unburned bones upon the same soils and crops, and with quantities of each which should contain equal weights of the earthy ingredients.

Numerous experiments were, in consequence, made in various parts of the island, few of them, however, exactly fulfilling *all* the conditions which were necessary to secure accurate comparative results. Some of them are recorded in the Transactions of the Highland and Agricultural Society, others have been published in the different agricultural periodicals of the day. I do not quote any of them, for they are not all concordant, but the general results were these :—

a Bones, under *favourable conditions*, seldom fail, when applied alone, in raising an average crop of turnips.

b Burnt bones, laid on alone, and in a quantity equivalent to that of an ordinary manuring with bones, do not always succeed in raising an average crop of turnips.

c In some rare instances, again, and upon some soils, burnt bones actually raised a larger crop of turnips than an equivalent weight of unburned bones.

Burned bones, therefore, as theory indicates, are useful to the land; but the employment of unburned bones is the safer and surer. This greater security must arise from the organic matter they contain, and therefore this organic matter cannot be without its use. Therefore, also, an artificial mixture, which contains nothing equivalent to this organic matter, can never be made to perform all the functions of bones. If the soil already contains a sufficiency of organic matter—or if this be added in the form of farm-yard or other similar manure—then burned bones, or artificial mixtures having a similar composition, will be sufficient to produce the usual effects of bones. But if organic matter be deficient, the entire bones will always be the farmer's surest reliance.

The general adoption of this sound view, is at present opposed by the notion which many have been led to adopt, that if plants can only obtain saline matter from the soil, they will draw organic food enough from the air. The ammonia of the atmosphere, it is said, will give nitrogen enough to the plant, and thus, in the case of bones, their organic matter is useless, since the air will readily yield to the plant what we suppose this organic matter to impart to the roots. But I believe the minds of our thinking men will soon be disabused upon this point, and that, in a few years, this opinion will have found its long resting-place among

the other singular fancies which, year by year, afford ephemeral occupation to the novelty-loving among our gentlemen farmers.

§ 4. *Analogy in Composition between Bones and Guano.*

There is a striking analogy in composition between bones and guano, which is, for other reasons, interesting to the practical man, but is especially important in connexion with the object of the present paper.

The following table exhibits the composition of bones compared with the average composition of good Ichaboe guano, supposing both in the dry state. Bones, as they are applied to the land, contain about 18 per cent. of water, Ichaboe guano from 20 to 25 per cent :—

	Bones	Guano *
Organic Animal Matter, ...	33	56
Phosphates of Lime and Magnesia, . .	59	26
Carbonate of Lime, ...	4	6
Salts of Soda, ...	4	10
Salts of Potash, ...	trace	trace
Siliceous Matter, ...		2
	100	100

If we compare these two columns, we see that bones and guano contain essentially the same things. There is an organic part in both; both contain a large per centage of phosphates; and there are salts of soda and a trace of potash in both. But they differ in the proportions in which these several constituents are present. Thus—

a The organic matter is in larger proportion in the guano. It is to be observed, however, that this organic matter is in the guano in a very decomposed state. It consists of salts, (oxalates, carbonates, &c.,) of ammonia mixed with dark-coloured matter, (humic acid,) and water of crystallization. In the Ichaboe guano, the ammonia rarely exceeds six or eight per cent. of the whole weight. But this proportion of ammonia we have seen that the gelatine of the bones will produce, when it undergoes complete decomposition. On the whole, therefore, I am inclined to think that the organic matter in a cwt. of bones is nearly of equal value to vegetation with that in a cwt. of Ichaboe guano. Those who are doubtful upon this point may easily supply any supposed deficiency in the former, by the addition of a few pounds of sulphate of ammonia.

b The proportion of the phosphates in bones is twice as great as in the Ichaboe guano. In this respect, therefore, bones are decidedly the more valuable.

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* This composition of Ichaboe guano is the approximate average of several hundred samples examined in my laboratory. The Saldanha Bay guano contains about twice as much of the phosphates of lime and magnesia, and a proportionately less quantity of organic matter.

c The soda salts are generally in somewhat larger quantity in guano. They consist chiefly of common salt, mixed, in the case of guano, with a variable proportion of sulphate of soda. If any stress be laid upon this difference, it is easy to remove it, by adding to the bones a few pounds of sulphate of soda, which can be bought at a very moderate cost.

From this comparison between bones and Ichaboe guano we are entitled to infer—

(1.) That what can be said of the value and permanent effect of the one manure may almost with equal truth be said of the other.

(2.) That we can fully supply the place of the one by the use of the other; and, what is more important to our present purpose,

(3.) *That, weight for weight, bones ought to go farther than Ichaboe guano in fertilizing the land.*

§ 5. *Why Bones do not, weight for weight, and in all cases, produce an equal Effect with Guano.*

But if this latter inference be true, why do bones not produce in all cases an equal effect with guano? Why are eight or ten cwt. of bones required to raise an average crop of turnips, while four or five cwt. of guano will fully serve the same purpose?

There are two reasons—a mechanical and a chemical reason.

a The mechanical conditions of the guano and of the bones are very different. The one is in the state of a very fine powder, the other is in hard tough pieces, difficult to break small, and, therefore, even in our bone-mills, reduced only to a very coarse powder. This mechanical condition has long been known to affect the action of bones. Not only do large bones lie long in the soil without undergoing much visible change, but even when broken their efficiency as a manure is known to depend much upon the degree in which they are crushed. Thus, where twenty bushels of bone-*dust* are considered, as in Yorkshire, to be a sufficient manuring for an imperial acre, forty bushels of *inch bones* are considered necessary to produce an equal effect. It is to be presumed, therefore, that a very much smaller quantity would act as efficiently, if the state of mechanical division in which the bones are applied could be made to resemble that in which the ingredients of guano are laid upon the land. Could bones be easily ground to fine meal, they might often be more usefully and more economically employed than they have hitherto been.

b The chemical condition of the organic matter is different in the two substances. In guano, it is already in a great measure in a soluble state. Oxalate and carbonate, and even some phosphate and sulphate of ammonia, exist in it—all of which are readily taken up by water and conveyed at once to the roots of

plants. The salts of soda are also in a soluble state, and thus the moment that guano is applied to the land, it is fit to minister to the progress of vegetation.

With bones it is otherwise. The gelatine they contain is very sparingly soluble in cold water. It must undergo a chemical change before it becomes readily soluble, and this is a work of some time. The organic and inorganic matters also envelope each other, and mutually interfere with each other's action.

From these differences, two consequences necessarily follow. The action of bones is more slow than that of guano, and the entire good which they *might* effect is seldom produced by them, either upon the soil or upon the crop.

§ 6. *Methods adopted for Increasing the sensible Effect of Bones.*

Without referring much to the effect which bones might theoretically be expected to produce, it has been observed by practical men that they may be made to act more quickly and more beneficially by the adoption of certain previous precautions, such as,

(1.) *Reducing to fine powder.*—I have already alluded to the fact, ascertained by experience, that the finer the powder, the more immediate and the more sensible the effect of bones. But practical men were afraid to venture too far in diminishing the quantity of manure they added to the soil. Bulk was considered to enter as an element into the fertilizing capabilities of any substance. Many leases even prohibit the addition of less than sixteen or twenty bushels of bones when used alone in the raising of turnips. But, under the guidance of science, both tenants and proprietors will, by-and-by, learn to estimate more correctly what the crops really carry off, and what the soil therefore requires. Thus a strictly scientific economy will be established, and no more of anything will be added to his fields than the farmer knows and *understands* to be necessary to maintain them in a state of permanent fertility. No more than this will be required by the proprietor.

(2.) *Heating the bones.*—In some districts their action in hastening forward the young turnip, and bringing it quickly into the rough leaf, when it is safe from the attacks of the fly, is increased by laying up the bones in a heap, and covering them over with earth, for a week or ten days before they are drilled into the land. Left in this state, they heat, soften, and begin to change or decompose, and thus, when laid in the drills near the seed, they are ready to furnish nourishment to the young plant as soon as the roots first thrust themselves downwards from the sprouting seed.

(3.) *Fermenting them with dung.*—Or, the same decomposition is

effected and carried further by mixing the bones with farm-yard manure, and leaving the mixture a while to ferment. It was the result of trials made by thirteen different persons, and which are recorded in the Doncaster report, that a given weight of bones, when mixed and fermented with farm-yard manure, invariably produced a more beneficial effect than the same weight of dry bone-dust, applied to the same crop and upon the same soil.

The advantage which results from these several methods, arises from the effect which they produce either in diminishing the mechanical coherence of the particles of the bone, or in altering by incipient decomposition the chemical state of the organic matter it contains. None of them, however, sufficiently effect these objects, though I do not doubt that fine bone-dust, fermented for two or three months with farm-yard manure, and occasionally turned over, would be brought into a condition more nearly approaching to guano, in its fertilizing virtue, than any other form of bones which has hitherto been *generally* employed.

§ 7. *Decomposing and Dissolving Bones by means of Sulphuric Acid.*

But another mode of preparing bones has recently been introduced, and for two or three years has been extensively employed as a part of the ordinary husbandry, especially by some of the Scottish farmers. This mode consists in decomposing, and more or less completely dissolving, bones in sulphuric acid, (oil of vitriol.) This may be done in various ways, and the prepared bones may either be applied in a liquid state, with a watering-cart, or may be dried and sown with the drilling machine or broad-cast, like ordinary bone or rape dust.

a The bones, in the form of bone-dust, or, where bone-mills are not at hand, simply broken in pieces with a hammer, may be put into a cast-iron, stone, earthenware, or strong wooden vessel, mixed with half their weight of boiling water, and then with half their weight of the strong oil of vitriol of the shops, stirring constantly while the latter is slowly poured in. A powerful boiling up or effervescence at first takes place, but which gradually subsides. By occasional stirring, the whole assumes the appearance of a thick paste, the pieces of bone disappear by degrees, and after a week or ten days the whole may be taken out and mixed with a little saw-dust, charcoal powder, charred peat, or fine dry earth, to make it dry enough to pass through the drill, and may thus be immediately applied to the land. It would, however, be better to prepare the bones a month at least before using them, and to lay them up in a heap for a while, with a view to their more perfect decomposition. Where the pieces of bone are large, this

is especially desirable, as otherwise they will not be fully decomposed without a larger addition both of water and of acid.

b Or the mixture of acid and bones, as above, may, after a couple of days, be further mixed with a quantity of light friable soil, and laid up into a heap for seven or eight weeks, with occasional turning. The bones thus heat, decompose, and dry up, so as to be ready for putting into the drill without further preparation. This method, however, requires more acid, and it is not unusual in employing it to take equal weights of acid and of bones. Some practical men, indeed, employ invariably equal weights of acid and of bones, while others are satisfied by mixing the bones with one third or even one-fourth of their weight of acid. I would myself employ not less than a half.

c Or equal weights of bone-*dust*, of boiling water, and of acid,* may be mixed together, and occasionally stirred for a week or ten days, and when the particles of bone have nearly disappeared, from fifty to one hundred times more water may be added to the mixture, and the liquid, thus diluted, may be applied by a water-cart.

If it is to be used upon grass-land in the spring, or to young corn, it will be safer to dilute it with 200 waters, but 50 waters (by weight) will be enough, if it is to be applied to the turnip drills. A common watering-cart, used for other liquid manures, will serve for the former purpose. For applying it to the drills a very ingenious addition of tubes to this cart has been contrived by Mr Wagstaff, and employed by him under the direction of the Duke of Richmond at Gordon Castle.

This method of applying the bones in the liquid form, is, no doubt, the most perfect, and may ultimately prove the most profitable, but it is also the most troublesome and expensive, and may not, therefore, come so soon into general use.

Instead of sulphuric acid, the muriatic acid, or spirit of salt, has been, indeed was first, tried for this dissolution of bones, but the former appears at present, for several reasons, to be preferred.

§ 8. *Comparative Effects of Dissolved Bones.*

The first experiments with dissolved bones were made in 1841, by Mr Fleming of Barrochan. The result is published in the Appendix to my published *Lectures on Agricultural Chemistry and Geology*, p. 28. He dissolved his bones by means of muriatic acid, and applied them to moss oats. In his report to me, published

* A gallon of water weighs 10 lbs., a gallon of acid 17 or 18 lbs.

as above, he says, "I examined the oats a few days before they were cut, and was much satisfied with their appearance. The straw appeared as stiff and shining, and the ear was as well filled, as if it had been grown upon stiff loam, and I *consider the same dressing* [he had applied it as a top-dressing sown broad-cast upon the young corn,] *applied to grain crops upon moss, will insure a good crop of well filled-oats.*" In 1842 he made many additional experiments, which he was kind enough to communicate to me for publication in my *Lectures.* Those upon oats confirmed the results of 1841, but I quote only the following comparative results from the Appendix, p. 80. The turnips and potatoes were raised with bones alone, without other manure:—

Produce from an Imperial Acre.

	Dry Bone-dust.				Bones in Muriatic Acid.			
	16 cwt.		18 cwt.		4 cwt.		10 cwt.	
	tons	cwt.	tons	cwt.	tons	cwt.	tons	cwt.
Swede Turnips	14	17	..	..	..	..	18	11
Red Don Potatoes	..	..	9	15	12	15	..	..

Both of these results, as I then observed, were greatly in favour of dissolved bones. In the case of the potatoes he found the produce a little augmented by the addition of wood-ashes.

Since that time, numerous experiments with dissolved bones have been made in Scotland. In Fifeshire, good crops of turnips have been raised at a cost of not more than 8s. or 10s. an acre. In Ayrshire, Mr Tennant of Shields, as early as 1842, used on his own farm as much as 200 bushels of bones prepared as above described, (§ 7, *b*,) and he found two and a-half bushels to be equal in effect to two cwt. of Peruvian guano. In 1843, a premium, offered by the Morayshire Farmers' Club, caused numerous experiments to be made in that county. I have given an abstract of the very important results of these experiments in the 4th edition of my *Elements of Agricultural Chemistry*, p. 155, and the report has since been republished in full in the *Journal of the Royal Agricultural Society of England*, v., p. 447. In 1844, the premiums of the Highland and Agricultural Society led to many other experiments, the results of which, made in different ways, and upon different soils, are published in their Transactions for 1844. The general conclusions are—

(1.) That eight, four, and in some cases, even two bushels of dissolved bones will produce as good a crop of turnips as sixteen or twenty bushels applied in the usual form. The crops also start more quickly and grow more rapidly.

(2.) That the more complete the state of solution and subdivision of the bones, the greater the effect. Hence, when applied in the liquid state the benefit is most apparent.

§ 9. *Why Bones Decomposed by means of Sulphuric Acid act more Beneficially.*

Why bones thus dissolved and decomposed act more beneficially will be in part understood from what has already been stated. Their particles are mechanically separated from each other—they can thus be spread over a larger surface of ground—can be more intimately mixed with the soil—and can be more quickly, readily, and completely taken up by the roots of the plants.

But besides this important mechanical alteration, the bones, before they are applied, have undergone an important chemical change, which has much influence upon their after action, and which it is important, therefore, fully to consider and understand. They contain also a new substance, sulphuric acid, the value of which ought to be clearly appreciated. Hence,

1*st*, It is not merely bones or their constituents that we add in the form of dissolved bones: *we add along with them a quantity of sulphuric acid.* This sulphuric acid is required by plants,—it is especially present in large quantity in the leaves of the turnip and the potato—even the tuber of the potato often contains more sulphuric than it does of phosphoric acid. The growth of these plants, therefore, must be proportionately more rapid when they can readily obtain this acid and in sufficient abundance.

A curious experiment was made last year by Mr Wood of Colinsburgh, on the home farm of Colonel Lindsay of Balcarres, which gives additional weight to this conclusion. He applied diluted sulphuric acid alone upon some of the drills in an experimental turnip field. The crop was inferior to that which was manured in the ordinary way with guano and dung, but far superior to that which grew on a patch to which nothing whatever was applied.

Some of the superior virtue of the dissolved bones is, therefore, to be ascribed to the fertilizing action of the sulphuric acid they contain.

2*d*, It is of consequence to attend to the chemical changes produced by the sulphuric acid upon the two—the organic and the inorganic—constituents of the bone.

a Action of sulphuric acid upon the organic matters.—I have already fully adverted to what I believe to be the real value of the organic part of bones, as the source of a portion of their fertilizing qualities. I have also noticed the importance of applying this organic matter in a soluble state, or of bringing it into such a state in the soil. Now sulphuric acid dissolves it, and, therefore, fully attains this end. But it does more: it decomposes it, and converts it into new compounds, which are very readily soluble in water.

One of these compounds is a sweet substance, to which the name of gelatine sugar is given. It is represented by

	C.	H.	N.	O.
Gelatine Sugar, . . .	8	9	2	7
Gelatine itself being, .	13	10	2	5

Like gelatine, therefore, this sugar contains much nitrogen, and can supply this important food to the growing plant. It may, as I think, supply it directly by entering at once, and without ultimate decomposition, into the roots of the plant, or it may first undergo decomposition in the soil, or before it is buried in the soil, and may thus supply nitrogen in the form of some salt of ammonia. How this may take place, will appear by considering that, if from

	C.	H.	N.	O.
Gelatine Sugar, . . .	8	9	2	7
We subtract				
One-half of Cane-sugar,	6	5	0	5
We have Urea, . . .	2	4	2	2

and this urea, in the presence of water, is readily converted into *carbonate of ammonia.*

We do not know that this gelatine sugar is actually a compound of urea and cane-sugar, but the above *possible* formula will satisfy those who believe in the influence of nitrogen upon vegetation, only when it is in the form of ammonia, that their favourite compound may be produced in a very simple way from the substances into which gelatine is converted by the action of sulphuric acid.

I can, unfortunately, quote no experiments in proof of the actual efficacy of the organic matter of bones dissolved in sulphuric acid and applied alone as a manure to any crop, for no such experiments have yet been made. But it cannot, I think, be doubted by those who have candidly and thoroughly considered the subject.

I would venture, therefore, to suggest that this method of reducing refractory substances by means of sulphuric acid should be tried by the practical farmer upon other substances having a composition similar to that of gelatine. Why should not woollen rags be dissolved in sulphuric acid, and applied in a liquid form to the roots of the hop-vines? If they are worth £5 a ton to lay up for a year in a compost till they fully decompose, they ought to be worth more when a method is known by which they can be completely divided, decomposed, and applied immediately. The parings of horn, of skins, and, above all, the leather parings of the shoemakers, might be easily worked up in this way. I do not despair even of seeing old shoes and hats, now disdain-

fully rejected even from the dung carts, carefully collected, as bones now are, in all our villages, and converted into a valuable manure. The wool of the hat and the leather of the shoe are richer in nitrogen than their own weight of dried fish or flesh. To make them as useful to the land, it is only necessary to reduce them to an equally soluble state.

b Action of the sulphuric acid upon the inorganic matter of the bone. The result of this action is the production of three changes.

First, The carbonate of lime in the bone is decomposed. The carbonic acid it contains is driven off in the form of gas—being one cause of the boiling up which takes place when the sulphuric acid is poured upon the bones—and the lime is converted into *sulphate of lime* or gypsum.

Second, A part of the lime contained in the *insoluble* phosphate of lime is also converted into sulphate of lime or gypsum, while the remainder of the lime, and the whole of the magnesia, forms *soluble* phosphates with the whole of the phosphoric acid. This soluble phosphate is sometimes called *Bi*, sometimes *Acid*, and sometimes *Super* phosphate of lime. Under the last of these three names it now finds a place in the manure market.

Third, The salts of soda are also converted into sulphates, or they divide themselves between the two acids, as the lime and magnesia partly do, and form a mixture of sulphate and phosphate of soda.

Thus the dissolved bones contain gypsum, soluble or super phosphates of lime and of magnesia, with a small quantity of sulphate and phosphate of soda. All these compounds are soluble in water; the phosphates, of which the plant requires at certain seasons of its growth a ready supply, are especially so, and thus all the inorganic matters which the bones contain are brought into a condition in which they can readily, and without any waste, be made available for the nourishment of the plant.

In consequence of the belief that the inorganic part of bones was alone useful to vegetation, numerous persons have been at the trouble to burn bones and afterwards dissolve the residue in sulphuric acid. Six hundred pounds of burned bones are reduced to fine powder, moistened with water, and then mixed intimately with 60 lbs. of strong acid, and thrown into a heap. This preparation is sold and applied under the name of super-phosphate of lime.

The employment of this substance as a manure has presented us with some interesting and curious facts. Tried upon turnips, a friend in Kirkcudbright informs me it has been found equal to its own weight of guano. But among the most precise experiments made with it are those of Mr Strouts of Kingsdown in Kent. When top-dressed with it, his clover was increased one-

half. His wheat, sown after clover lea with farm-yard manure ploughed in when the wheat was sown, was also top-dressed with it, with the following comparative results :—

	Per Imp. Acre.
No dressing gave . . .	$29\frac{1}{4}$ bushels.
$3\frac{1}{2}$ cwt. of Peruvian guano,	$40\frac{3}{4}$,,
5 cwt. of rape-dust, . .	$38\frac{3}{8}$,,
$6\frac{1}{4}$ cwt. of super-phosphate,	$53\frac{5}{8}$,,

This result alone abundantly proves the value of the inorganic substances of the dissolved bone as an application to the land.

I am acquainted with only one experiment upon the comparative value of burned and unburned bones when applied in combination with sulphuric acid. This experiment was made by Mr Hannam. He found that the bones he employed burned away to half their weight. He therefore applied

		Turnips per Acre. Tons.	Cwt.
1. Bone-dust, 8 bushels Sulphuric acid, 168 lbs. Water, 604 lbs.	and obtained . . .	17	9
2. Bones, 8 bush. (burned to half their weight,) Sulphuric acid, 84 lbs. Water, 252 lbs.	and obtained . . .	13	7

This is evidently not in favour of burning bones, and by no means illustrates the prudence of those practical men who in some parts of England have been burning them in tons at a time, with the view of afterwards decomposing and dissolving them by means of sulphuric acid.

I do not found much, however, upon the result of a single experiment, and, in fairness, it is proper to add here two remarks. 1*st*, That in the above experiment the quantity of acid used with the burned bones was only half of that used with the un-burned, and, therefore, if any efficacy is to be ascribed to the sulphuric acid—which, by all these experimenters, was supposed to act merely in mechanically dividing it—we should have anticipated a smaller return from the former. 2*d*, Supposing the quantity of acid to have been the same, and that the crop from the burned bones had been the greater, it would still not have shewn that the organic matter was of no value. It would have shewn only, what we are prepared to admit, that the soil we are cultivating may sometimes be so rich in certain kinds of organic matter, that the application of a small quantity more will not for the time produce any sensible improvement of the crop.

But though these experiments with the burned bones will not induce the prudent man to commit the waste of time, money, and material, which burning his bones implies, yet one useful conclusion we do draw from them, which may lead to a more economical

employment of other fertilizing substances. The refuse animal charcoal of the sugar refiners is extensively employed, and in most places eagerly purchased as a manure. In France, it is much used as a manure for the vine, and is imported largely from other countries for that purpose. But if bones, when entirely burned, be so much more beneficial to the land after being dissolved in sulphuric acid, it is reasonable to expect that this animal charcoal, which consists chiefly of charred bones, should be improved in a similar degree by the same mode of treatment. I have no doubt that it will hereafter be found much more profitable to apply this refuse in a liquid form either to the vine, to fruit-trees, or to any other crop. Indeed we are scarcely left to conjecture on this point, since Mr Fleming of Barrochan has obtained striking results both in the case of hay and of potatoes from top-dressings of which this animal charcoal dissolved in sulphuric acid formed an important part.*

3. *The acidity of this preparation of bones* is deserving of notice in connexion with the theory of its action in promoting the growth of plants. The reader will easily understand how the addition of so large a proportion of acid to bones should render the whole very sour, and he might readily enough suppose that this sourness would render it injurious to the roots or to the whole plant. But recent researches seem rather to point to a contrary conclusion—that the sourness, in fact, is likely to favour the growth of the plant. In a work entitled "*Die Entdeckung des Pflanzennahrung*," Professor Schultz of Berlin has lately detailed numerous experiments of a very interesting kind, which shew that the leaves and roots of plants possess the power of decomposing many acid substances, when presented to them in the free or acid state, and of liberating oxygen from them, though they refuse to do so altogether, or do it very sparingly, when the acids are in a neutral state of combination. Acids also promote this decomposing action of the parts of plants upon solutions of sugar and of the humic acid and other soluble substances which are contained in the soil. Among the acids which promote this action of the roots and leaves upon substances with which they are in contact, the sulphuric and phosphoric acids are among the more energetic. It is not unlikely, therefore, that the state of acidity of this preparation of bones may in reality exercise an important influence in augmenting its

* A mixture of bone charcoal 1 cwt. sulphuric acid 36 lbs., carbonate of magnesia 28 lbs., sulphate of magnesia 28 lbs , muriate of ammonia 28 lbs., and carbonate of soda 56 lbs., applied as a top-dressing to his grass, gave him an increase of 1¼ tons of hay over that which had not been dressed. A similar mixture, substituting common salt 1 cwt., gypsum 1 cwt., and nitrate of soda 28 lbs., for the three last substances in the former mixture, gave, with 15 tons of dung, a crop of 20 tons 3 cwt. of potatoes, while 35 tons of dung alone, gave only 19 tons 2 cwt. per imperial acre.

effect as a manure. Would it not be worth while to test this by trying the effect of rendering other manures sour? The result of Mr Wood's application of sulphuric acid to his turnip crop, as above mentioned, would seem to answer this in the affirmative. But we must be cautious in our conclusions as well as in our predictions, since the effects usually ascribed, among others, to the application of lime—that it acts beneficially by neutralizing acids in the soil—seems completely at variance with the conclusion to which Mr Wood's experiment appears to point.

One curious fact, however, seems to derive a practical explanation from these observations of Professor Schultz, upon the effect of acids in promoting the action of the sap upon solutions of sugar and similar organic substances. An intelligent correspondent of mine at Drumlanrig, in Dumfriesshire, has tried the steeping of his barley seed in dilute sulphuric acid, and has found that, when so prepared, it not only took the lead of the unsteeped, but continued better during the whole summer, and yielded him a much larger crop in autumn. It is probable that the acid in this case does not act in directly feeding the plant, or not solely in this way, but in enabling also, or disposing, the young grain to work up more rapidly the different kinds of natural food prepared for it in the grain, and thus to take a more healthy and ravenous hold, as it were, of the soil, when it sends out its roots among it in quest of food.

§ 10. *Ought any other Substances to be mixed with the Dissolved Bones?*

Bones are known to exercise a comparatively feeble and uncertain action upon stiff and undrained clays, and it may, therefore, be reasonably asked by some if the action of dissolved bones will be more certain upon such soils than the bones in their natural state. We may, I think, answer this in the affirmative, since the principal cause of the less conspicuous effect of bones upon such soils is to be found in their tenacity and coldness, by which the particles of bone are shut out from the air, and their decomposition is retarded.

But, inasmuch as bones do not contain the whole of the substances which plants require, and as some of those which are present in bones—the salts of soda, for example—are present in small quantity only, it may reasonably be asked again if the dissolved bones would not be improved, and their efficiency increased and rendered more *sure*, were an addition of certain other substances to be made to them. Of this I think there can be little doubt, though the necessity and nature of such additions will depend much upon the nature of the soil to which they are to be applied.

A small per-centage of pearl-ash or wood-ashes, of nitrate of soda or common salt, and of sulphate of magnesia—five pounds each of the potash and soda salts, and ten pounds of the magnesia salt, to each hundred pounds of bones—would render the mixture more suited to every soil and to every crop. At the same time, if the soil, like those formed from the felspar rocks, abound in potash, or, like those which border the sea, be rich in soda, or like those which owe their origin to the talc slates or to the magnesian limestones, contain already too much magnesia, any addition of potash of soda, or of magnesia, would, in these several cases, obviously be thrown away. The principle of adding such things being recognised as sound, the knowledge and discretion of the farmer must be exercised in determining how far such additions are likely to be profitable. Or he may make small preliminary experiments by way of trial.

It may be said by some that guano and bones are both alike deficient in silica, which exists so largely in our grasses and in the stems of our corn plants; and, therefore, that some soluble silicate might with advantage be added to either of these manures, when crops of corn are to be improved by them. There is much show of reason in this when considered theoretically, and there are, no doubt, cases in which an admixture of one-fifth of its weight of silicate of soda would improve a guano, or in which the use of sulphated bones for the turnip crop might be beneficially followed by a top-dressing of silicate of soda upon the young corn of the following year. But the propriety of incurring the expense of such an application along with bones in *all* cases is very doubtful. Here also much will depend upon the actual constitution of the soil; for it would be a waste, as I have already said, to add anything which the soil already contains abundantly, and in a state in which it can readily minister to the wants of the plant. But to this topic I shall advert more particularly in the immediately subsequent article.

In conclusion, I may remark that the more extended use of this mode of preparing manures—creating, as it must, an increased demand for sulphuric acid, and, consequently, for the raw materials from which this acid is manufactured—will exhibit another illustration of that intimate connexion which, in a country like ours, must always, in a healthy state of things, exist between the agricultural, the manufacturing, and the mining interests, and of the certainty with which the advancement of the first of these interests must lead to the greater extension and prosperity of every other department of the national industry.

DURHAM, *9th May* 1845.

VII.—ON THE PRESENCE OF SILICATES IN THE SOIL.

In the close of the preceding article I have adverted to the propriety of mixing silicate of potash or soda with guano or dissolved bones before applying them to the land. As the use of these silicates is at present much recommended, it may be proper to consider how far they are really necessary to the soil.

1°. If a portion of soil be burned, in order to destroy the organic matter it contains, be then boiled in distilled water for a length of time, and the filtered solution be afterwards evaporated to dryness, and the residue heated to redness to burn off the organic matter, a minute but variable quantity of saline matter will remain, in which a *trace* of silica will usually be found. Most soils, therefore, contain some silica in a state in which it may be taken up by water.

2°. If, after boiling with water, the soil be digested for two or three hours with concentrated muriatic acid till it is perfectly colourless, and if the filtered solution be treated with ammonia and oxalate of ammonia, to separate the oxide of iron, alumina, and lime, and be then evaporated to dryness, an appreciable quantity of silica will be found in the saline matter which remains. Or, if the acid solution be at once evaporated to dryness, and then treated with water, some silica will remain insoluble. Soils, therefore, generally contain a further appreciable quantity of silica, in a state in which it is soluble in acid solutions.

In the following table, the last line but one shews the proportions of soluble silica thus obtained from four different soils analysed in my laboratory:—

	Auchengate Farm.	Thanderlyhall Farm, Essex.	Stemster, by Thurso	White-hill, Lasswade.	Kirkcudbright.	
					Top.	Bottom.
Organic Matter, .	14.15	4.27	8.43	6.64	26.86	18.57
Alkaline Salts, soluble in Water and Acids, . . .	0.06	0.94	0.49	0.20	1.41	0.46
Gypsum, . : .	0.02	0.02	0.03	0.09	0.11	0.07
Oxide of Iron, .	2.09	7.00	5.61	4.46	4.37	5.93
Alumina, soluble in Acids, . . .	0.60	5.14	3.08	1.08	2.44	2.90
Carbonate of Lime,	0.12	1.05	0.25	2.32	2.26	1.47
Carbonate of Magnesia, . . .	0.26	0.78	0.45	1.02	0.70	1.86
Soluble Silica, .	0.19	0.16	0.20	0.17	0.84	0.42
Insoluble Siliceous Matter, ...	82.95	80.29	80.39	83.31	60.47	67.24
	100.44	99.65	98.93	99.29	99.46	98.92

I could have given many other such results, but these shew

both the presence of silica in this state in our cultivated soils, and how much it varies in different soils. In the fifth column it is four times as great as in the first and second.

The quantity present in the first two columns—1-5th of a per cent., or one pound in 500 lbs. of soil—appears very small when compared with the whole soil, and yet it proves to be large when we come to calculate how much an acre of soil will contain, and how much a crop of corn will carry off from that acre. A square yard of soil, twelve inches deep, will weigh about 700 lbs., so that this extent of soil will contain $1\frac{2}{5}$ lbs. of silica soluble in acids, which amounts to 6,700 lbs. in an acre!

The straw of our grain crops leaves, on an average, less than five per cent. of ash, of which less than one-half usually consists of silica, and a crop of straw rarely exceeds 3,000 lbs. per imperial acre. If we take these numbers as tolerable approximations, the quantity of silica carried off by a crop of straw amounts to 75 lbs. per acre, while the silica soluble in acids, and which it is believed plants can take up, amounts, as above, to 6,700 lbs. Or this silica will alone supply the wants of 900 crops of corn.

The soil in the fifth column contains four times as much, or it would provide silica for 3,600 crops!

3°. If the insoluble portion of the soil be washed with water, to free it from siliceous sand, and the finer or clayey part be collected and fused with carbonate of soda, and then treated with muriatic acid, a large portion of silica, in light white flocks, will remain behind; while the solution will contain alumina, lime, magnesia, and perhaps potash and soda, with which the silica had been combined in the soil. This portion of the silica of the soil is very large, and sometimes forms nearly one-half of its whole weight. In the form of silicates insoluble in muriatic acid, therefore, the soil contains an enormous quantity of silica.

There can be no doubt that the roots of our corn-crops are capable of taking up and appropriating that portion of the silica of the soil which is soluble in water, but it may be doubted by some if that which is taken up by acids, and especially if that which acids leave undissolved, is capable of supplying the wants of our growing crops.

I will not offer here any of those theoretical considerations which induce chemists and physiologists to believe that both the silicates which are soluble and those which are insoluble in acids are really a source of mineral nourishment to the plant.

An appeal to experiment will be much more satisfactory to the practical man.

Wiegman and Polstorf * took fine white quartz sand, burned it

* Ueber die Unorganischen Bestundtherle der Pflanzen-Braunschweig. 1842.

to destroy any organic matter it might contain, digested it for sixteen hours in strong nitro-muriatic acid, and then washed it with distilled water. Everything soluble being thus removed, seeds of different kinds, barley, oats, buckwheat, vetch, clover, and tobacco were sown in it, and watered with distilled water. They all grew and came to a greater or less height. The ash left by separate portions of the seeds and plants, when full grown, was determined and analysed. In the following table I have put together their comparative results, in so far as the silica is concerned, as well as the height to which the plants had arrived when they were gathered:—

	HEIGHT.	SILICA IN THE ASH.		SILICA had Increased
		Of the Seed	Of the Plant	
	Inches			Times
Barley, . . .	15	0.034	0.355	10
Oats, . . .	18	0.064	0.354	5½
Buckwheat,	18	0.004	0.075	18
Vetch, . . .	10	0.013	0.135	10
Clover, . . .	3½	0.009	0.091	10
Tobacco, . .	5	0.001	0.519	500

Thus it appears that, from quartz sand, after it has been digested in strong acids, plants are able to extract silica as well as other kinds of inorganic nourishment, to which, in the above table, I have not alluded. The sand in which the plants had grown, was found, upon analysis, to contain 97.9 per cent. of pure silica, the remainder consisting of potash, lime, magnesia, alumina, and oxide of iron.

From this experiment, therefore, we are justified in concluding that plants are capable of decomposing and extracting silica even from those silicates in the soil which are not attacked by acids. How much more easily may they decompose and appropriate the constituents of those silicates which are capable of being decomposed and dissolved by acids!

Nor is it in virtue of any mysterious power that this decomposition is effected. The prolonged action of water containing carbonic acid, slowly decomposes even the most refractory silicates. The water in the soil is more or less charged with this carbonic acid—the decaying vegetable matter of the soil produces it, and the roots of living plants give it off—so that a simple chemical action is sufficient to explain how the plant can obtain food from such unpromising materials.

It is an important conclusion, therefore, for practical agriculture, that the silica, which is so necessary to the growth of our corn and hay crops, abounds so much in nearly all our soils, and

in a state in which the roots of plants can more or less readily take it up. It satisfies us in regard to three points.

a As to where and how the plants obtain their silica.

b That, *in general*, it cannot be necessary to add silica in any form as a manure to the soil, and, therefore, that—

c The broad assertions of those who say that guano or bones should always be mixed with silicate of potass or soda, and who ascribe certain alleged failures of these manures to the absence of such silicates—that these assertions are hastily made and are not to be depended upon. I believe there are very few soils indeed, which, *if properly treated otherwise*, will refuse to yield good crops merely because a soluble silicate has not been added to them.

VIII.—OF THE USE OF SILICATE OF SODA AS A MANURE.

Is the use of silicate of potash or soda, then, not to be recommended? Are there no circumstances under which it may prove profitable to the practical man? These are questions which, notwithstanding what has been said in the preceding article, it would be premature to answer in the negative.

Soils which contain thousands of pounds of potash and soda in a state of chemical combination, from which plants can obtain it by degrees, are yet often rendered more productive by the addition of a few cwts. of wood-ashes or common salt, from which the plants can obtain alkaline matter without delay. It may be so, therefore, with the silicates.

There is only one legitimate purpose, however, for which a silicate should be added to the soil—it is to supply silica to the plant. We ought not to add silicates for the purpose of supplying alkaline or earthy matter, unless some question of economy interferes. We use wood-ashes which contain silicates, because it is cheaper to add potash in this than in any other form.

There is only one evidence, therefore, that the addition of a *silicate* has done good to our corn crop—it must have given more silica, and consequently, as it is believed, more strength to the straw. That the crop has been generally improved, that it is more luxuriant and thriving, or even that it yields a larger return of corn, will not be a proof of the virtue of the silicate. The effect may result from the action of the potash or the soda it contains, and the use of these alone might have produced the same effect.

Oats grown upon a mossy soil are soft and dull in the straw, and I have found such straw to be deficient in silica. Wheat growing rankly upon a moist soil, and in a moist season, or a heavy thickly growing crop of barley, are apt to be laid by the wind, or to fall down under the weight of the ear. The straw

is too feeble in all these cases, and it has been said that the use of silicates would abate the evil. Lampadius found the growth of wheat and rye to be greatly promoted by the use of a soluble silicate of potash, but the alkali might be the cause of the effect observed, and no other experiments of an accurate kind have yet been made. The late Mr Oliver of Lochend applied silicate of soda, at my suggestion, to his corn crop last year, but his unfortunate death prevented the results from being observed.

It is still an open question, then, whether or not we have it in our power, at our pleasure, to strengthen the straw of our corn plants —whether it would be useful to apply the soluble silicates to all soils—whether there are any to which they may be applied with advantage and profit as an ordinary manure.

Irrespective of theory, it is important to determine this point. There are certain practical evils which it is desirable to overcome; will the use of silicates overcome them? Theory does her part best by practice, when, instead of boldly pronouncing upon doubtful points, she suggests experiments by which they are likely to be cleared up. It is a fair subject for trial, therefore, which I hope some of our skilful experimental farmers will take up. Silicate of soda may now be had of the Messrs Turnbulls of Glasgow, at 12s. a cwt. Mr Campbell of Craigie has some patches on trial. I hope others will follow his example. To eliminate the effect of the soda from the experiment, three experimental patches ought to be chosen in *duplicate* or *triplicate*. Thus :—

Nothing.	One cwt. of Silicate of Soda.	One cwt of Carbonate of Soda.
One cwt. of Carbonate of Soda.	Nothing.	One cwt. of Silicate.
One cwt. of Silicate.	One cwt. of Carbonate.	Nothing.

Not only should observations be made as to the rapidity and luxuriance of growth and to the strength of the straw, but an average sample of each of the straws should be analysed, for the purpose of ascertaining whether any more silica has really been taken up by the one part of the crop than by the other. Such experiments as these will, in a year or two, settle the point, and will free the practical man from the necessity of relying upon, or being guided by, the mere opinions and hypotheses of theoretical chemists.

In the preceding article I have alluded to an opinion which is causing hesitation among some of the members of the Association who have written to me on the subject, and is causing them to

doubt the propriety of using either guano or bones as a manure for their corn crops, without an admixture of a silicate of potash or soda.

Now, in reference to such an opinion as this, it is of importance to understand clearly, which very few yet do, the precise duty which scientific chemistry owes to practical agriculture. Were it the duty of chemistry to provide for the farmer a manure which should grow him any crop he chooses upon any soil, or upon any substitute for a soil, then, no doubt, a silicate would be a necessary ingredient of such a manure. But such is not the object of chemistry in reference to this branch of agriculture. It is a more complicated and difficult one. "Upon a given soil, and under a given mode of treatment, what must I add to raise a given crop at the cheapest rate?" That is the economical question which the farmer is entitled to ask of the scientific chemist. It will not do in reply to put into his hands a universal medicine which shall make every crop grow, sow it when he may. That may be more expensive than is necessary. It may contain substances which already abound in the soil in a form in which the plants can easily absorb them, and to add which is therefore clearly a waste of money.

Now as silicates abound to such an extent in the soil, as there are only a few cases in which crops really seem to languish, or to be subject to disease or casualty, because of the absence of silica, we ought to pause before we expend artificial silicates upon what may prove an ungrateful soil. Let their value be tried by a succession of careful experiments, and then the farmer will either be saved from such an expenditure of money, or he will be justified in laying it out on such manures by the reasonable hope of a fair return. Caution and economy must attend our steps in scientific farming, if we are to make a sure and steady progress.

Much evil has already arisen from confounding what is merely probable with what has been proved to be true, and from announcing both as equally certain. It is *probable* that upon certain soils the use of silicates may be beneficial to our corn crop. Experiments, therefore, ought to be tried with them. It has not been *proved* that they will really improve the crop upon any soil, and, therefore, they ought not, *as yet*, to be mixed with the guano, the bones, or the other manures which are to be applied to all our soils, indiscriminately.

IX.—OF THE COMPOSITION OF THE SLAG OF THE IRON FURNACES AND ITS USE AS A MANURE.

Mr Houston of Johnston Castle has lately recalled my attention to the slag of the iron-smelting furnaces, and its capability

of being employed as a manure. It is well known that, in smelting our clay iron-ores, a considerable quantity of lime is employed, with which the earthy matter of the ore forms in the furnace the grey or blue slag which is employed in many parts of the country in mending our roads. This slag, if it could be readily reduced to powder, should be an excellent addition to the soil in localities where lime is scarce or high in price.

With the view of ascertaining how much lime such slags contain, some specimens were sent to the laboratory of the Association, by Mr Houston, and were analysed by my assistant, (Mr Cameron.) They were found to consist of—

Lime,	39.47
Magnesia,	2.75
Alumina,	25.36
Silica,	32.19
	99.77

or, every 100 lbs. of this slag contains about forty lbs. of lime. Pure limestone contains only 44 per cent. of lime, so that this slag is about as rich in lime as most of our common limestones, and as the most of the marls, even of the shell-marls, which we apply to the land.

In my published "*Lectures on Agricultural Chemistry,*" p. 608, I had suggested the use of these slags as an application to the land, especially to peaty and moorish soils, upon which lime is known to be productive of much good. The result of the above analysis confirms that suggestion, and shews distinctly the amount of advantage which may be derived from the application, and the amount of loss which is undergone by the neglect and waste of this slag.

There are some localities where its profitable employment is distinctly indicated, as in the neighbourhood of Muirkirk, where the iron furnaces border upon the moor, and heaps of slag are wasted upon the unthankful stream, which would at once solidify and fertilize the adjoining heath and moss.

I have said that, if it could be readily reduced to powder, it might be beneficially applied. Of course the effect and benefit will be greater the finer the powder to which it can be reduced. It is often very brittle, and, therefore, easily crushed, though it is not unfrequently hard enough to make an excellent road metal. Mr Houston has found that, if allowed to run into water as it flows from the furnace it becomes very friable, and may be crushed for a shilling a ton.

As a question of economy, however, there are two points still to which the attention of the practical man will naturally be

drawn. Is it on the whole as cheap as quicklime, and will it act or answer as well?

1°. *Quicklime*, (lime-shells,) as it is obtained at the kiln, contains at least twice as much lime as an equal weight of the slag. Suppose, therefore, a ton of crushed clay to cost only 1s. 6d., as much lime as is contained in a ton of shells would, in the form of slag, cost 3s. Suppose the ton of lime to cost 5s., and take the cost of cartage at 6d. a ton per mile, then the one or the other will be cheaper according as the cartage is longer or shorter. Thus a ton of lime in the two forms will cost respectively,

	At the works or kiln.	Carted from the distance of 2 miles.	4 miles.	6 miles.
In the form of *Slag*, ...	3s.	5s.	7s.	9s.
In the form of *Shells*, ...	5s.	6s.	7s.	8s.

each mile, adding 1s. a ton to the cost of lime in the shape of slag, and only 6d. a ton in the form of shells; so that the expense of the slag, when brought two miles, is as great as that of quicklime brought from the same distance, and beyond this is greater, though the first cost is so different. But,

2°. When it is applied, will the lime contained in the slag be equal in efficacy with that which is applied in the state of quicklime? On this point it is to be observed,

a That its *immediate* effect will be less. The caustic property of the burned lime enables it to act with more energy in decomposing organic and inorganic substances in the soil. It will, therefore, produce a more sensible or directly visible effect, and thus, in many cases, ought to be preferred.

b Before it can be useful to the plant, the slag must undergo decomposition. The carbonic or other acids, produced in the soil by the decaying vegetable matter, must convert the lime into carbonate, or bring it into some other form of combination in which it can more easily become available in feeding and preparing food for the plant. In peaty soils, and such as are rich in vegetable matter, this decomposition will take place with greater rapidity, and hence its greater fitness as an application to such soils. Its action, however, will generally be more slow even than that of shell marl, but its effects will, of course, be more permanent.

c As the silicate of lime in the slag undergoes decomposition in the soil, the silica it contains will be liberated in a comparatively soluble state. This, in the opinion of some, is a circumstance of considerable importance. Silica is necessary, especially to our corn crops, and, therefore, anything which will supply it to the plant in a soluble state is supposed to possess much virtue as an application to the land. I have already, in a preceding article, shewn how plentiful a supply of soluble silicates most of our soils

contain. Still a soil may be comparatively poor in those forms or compounds of silica which readily yield to the plant this necessary ingredient. Peaty soils, which give a feeble straw to the oat, may be in this condition—and a part of the benefit which the crushed slag is fitted to render to such soils may be theoretically ascribed to the abundance of silica it may yield to the growing corn. I would not wish, however, to base my recommendation of its employment as an economical application to our fields on any other fact than the quantity of lime it contains. The application of lime alone to the land gives a stronger, smoother, and healthier straw. In the present state of our *experimental* knowledge, therefore, all we can, I think, with safety say, is, that the presence of the silica in the slag will do no other harm than to retard the action of the lime it contains, but that it is uncertain if it will do any good, and, therefore, that, in estimating its actual worth to the land, no money-value should as yet be placed upon the presence of this ingredient.

X.—OF BURNED SHELL-SAND AS A MANURE.

The value of shell-sand for agricultural purposes has long been recognised. Where it is scattered by the sea-winds over the shores of the western isles, it surrounds them with a beautiful edging of green, and when it is artificially applied, either to grass or arable land, it is almost uniformly beneficial.

It is a rule which applies to almost every kind of manure, that the more minute the state of division in which it can be laid upon the land, the more sensible and immediate are its effects. One of the great benefits which result from the burning of lime consists in the minute state of division to which it falls when it is slaked. After slaked lime has been exposed to the air for a length of time, it returns to the same *chemical* condition of carbonate of lime in which it existed in the native rock. But its mechanical state is different. It is in the state of an exceedingly fine powder, which can readily be spread over a large surface, can be intimately mixed with the soil, and can readily be made to undergo farther chemical changes in the soil.

The shell-sand of our coasts is often obtained in the state of a fine powder. In that form it acts better, and the same weight goes farther. But none of it is so fine as the powder to which slaked lime falls. It has, therefore, occurred to many that this shell-sand might be rendered more valuable by a partial burning. Shells readily fall to powder when heated; and, therefore, they could be so much burned as readily to crumble at a much less cost than an equal weight of limestone.

The shell-sand which is collected on our coasts contains a

variable proportion of sea-sand. This sometimes is as little as 5 or 10, but at other times it amounts to as much as 50 or 60 per cent. of its whole weight. This variation will, of course, affect its value as a manure in whatever state it is applied.

In consequence of this admixture of sand among the shells, it will unavoidably happen, during the burning of them, that, in those parts of the fire or kiln where the heat is greatest, a portion of the sand and lime will occasionally melt together, and form a *silicate of lime*, having some resemblance to the silicate of lime which exists in the clay of the iron furnaces described in the preceding article. So much of the lime as has thus been converted into silicate, will, of course, be less immediate in its action upon the soil, though it will be by no means without an ultimate good effect. When mixed with the soil, it will by degrees be re-converted into carbonate, and will at the same time liberate a portion of silica in that soluble state in which, in some soils, it may possibly promote the growth of the corn crop and strengthen the straw.

This roasting or burning of the shell-sand has been tried with success in Cornwall. By burning, it has been found to become so brittle as easily to be reduced to a fine powder, and in this powdery state it has produced on several farms a marked increase in the crops of roots and corn. This was, of course, to be expected, especially on cold undrained lands, and such as were naturally poor in lime. The native shell-sand would have produced the same effects in a less marked degree. Ordinary lime-shells, newly fallen or slaked, would have produced a fully equal effect. This method of burning the shell-sand, therefore, though it greatly improves it, does not give it virtues which other lime does not possess.

ON A NEW VARIETY OF BARLEY.

By the Rev. James Noble, St Madoes, Perthshire.

In the end of July 1838 I observed a single ear of barley in a field of the Dunlop species, which, from its marked difference from those around it, and also from any that I examined in the neighbouring fields, I supposed might turn out to be a *new species*. Accordingly I marked its position, and when it was ripe, secured it. In 1839 it was sown in a border of the garden, and from the produce retaining all the peculiarities of the original ear, and also from the unusual length, stiffness, and brightness of the straw, I felt no doubt that my first supposition was well

founded. The produce of 1839 (about a handful) was sown in 1840, and the result was a small sheaf. This yielded nearly a lippy, which, being sown in 1841, produced thirteen large sheaves, that, when thrashed, produced not quite a bushel. In 1842, as the produce of the bushel, I had about two quarters, not highly cleaned, but fit for seed. I was now persuaded, from the quantity returned in proportion to what was sown, (taking at the same time into consideration the quantity and the quality of the land where it was sown,) and also from the excellent tillering character of the barley, and the length and stiffness of the straw, that, while it was a *new*, it would also turn out to be a *valuable*, variety. And, accordingly, in 1843, I sowed the whole produce of 1842 in a field, which, in my ordinary rotation of cropping, was designed for barley—the previous crop had been wheat after potatoes, and there was no manure given to the barley. At the same time and in the same field there was sown a proportion of early English barley, mainly for the purpose of ascertaining the comparative earliness of the two varieties, though I had in view also the comparative productiveness. The result was that, in point of earliness, the English had the advantage by three or four days, but in point of productiveness the new variety had a much greater advantage, being at the rate of eleven bolls or sixty-six bushels per acre, while the rate of the English was not more than seven and a half bolls, or forty-five bushels, per acre. Those persons in the neighbourhood who saw the crop while growing in 1843, were so satisfied with its superiority in every respect, that all that I had to spare for seed was eagerly sought after; and I now find, from the testimony of those who made the trial of it and have proved it, that its high productive qualities as indicated in previous years have been fully maintained. One gentleman, viz., Mr John Rannie, Inchyra House, in this neighbourhood, sowed two acres seventeen falls Scotch, with a quarter of the new variety, and having thrashed the produce, he informs me that it is fully twenty-eight bolls, being at the rate of nearly fourteen bolls, of six bushels each, per acre. Mr Young, Cairnie Mill, on the estate of Pitfour, also in this neighbourhood, whose judgment in a matter of this kind is entitled to the highest respect, states to me generally that he is satisfied it will prove a valuable variety, particularly for light soil, and that, having himself sown six bushels of it, his return, in point both of quantity and quality, is much superior to that of the early English variety sown in the same field. In quantity he says that he has eleven bolls per acre. Robert Webster, Esq., of Balruddery, near Dundee, sowed a quarter of it, and he informs me that its superiority in his field had been obvious throughout the whole season, and though not yet thrashed, to shew how much satisfied he was with it, he said "he wished

that he had had his whole field sown with it." There are several other persons who sowed it, from whom I have not as yet obtained any report; but I have reason to believe that there is not any one among them who is not persuaded that it is a valuable variety.

Distinctive Characteristics.—The distinctive characteristics of this new species of barley are these:—(1.) Up to the time of ripening, the skin maintains a glossy whiteness without the slightest streak of brown, while all our other varieties are marked by more or less of a brown tinge, the ridges of the grain being uniformly streaked with a brown line. (2.) A second peculiarity is to be found in the brighter colour and greater strength of the straw than in the common varieties. (3.) And a third peculiarity is to be seen in the greater distance of the grains from one another on the ear than in the ordinary varieties, so that an ear of the new variety with twelve grains on each side, will be found fully three quarters of an inch longer than one with the same number of grains of either the Chevalier or early English kind.

Advantages.—The *superior productiveness* of the new variety is its most obvious and strongest recommendation, but for light soils especially *the length of its straw* must render it advantageous. Its *tillering properties* ought not be overlooked; and, particularly for *moist districts*, where barley is apt to sprout suddenly after being in the stook, *the distance at which the grains are placed from one another in the ear* may be regarded as a valuable qualification, inasmuch as moisture will not obtain such a ready resting-place, nor be so long retained as in a more compactly constructed ear.

COMMUNICATION FROM THE BOARD OF TRADE IN REGARD TO THE EPIDEMIC IN CATTLE.

Office of Committee of Privy Council for Trade,
Whitehall, 29th *July* 1845.

Sir,—With reference to the correspondence which has taken place with you on the subject of the epidemic disease said to be raging among cattle on the Continent, I am directed by the Lords of the Committee of Privy Council for Trade to transmit to you, for the information of the Highland and Agricultural Society of Scotland, the copy of a Report which has been received from Mr Consul Yearnes, at Odessa, upon this subject.—I am, Sir, your obedient servant,
J. Macgregor.

Sir Charles Gordon.

Odessa, 28th *April* 1845.

My Lord,—I have the honour of acknowledging the receipt, on the 20th ultimo, by a sailing vessel from Constantinople, of Mr Bidwell's dispatch consular, No. 2, of the 28th of January, containing the copy of a letter from the Board of Trade relative to a disease now prevalent among cattle, and whereby I am commanded by your Lordship to furnish all the information that I can obtain on the subject.

This distemper, having caused an immense loss of horned cattle in southern Russia, was mentioned by me in my dispatch consular, No. 7, of 28th February. I had there to lament the dearth of scientific observation and of authenticated facts, both wanted to throw light on the nature and extent of the calamity; and though my inquiries had not been discontinued, I have, since the duty has been specially imposed on me, felt more pressingly urged; yet I have reason to fear that I am still insufficiently provided with materials for a satisfactory account, and such as may be expected.

There are few veterinary surgeons in this part of the empire to be usefully consulted. The Agricultural Society, (Societé de l'Economie Rurale,) founded in Odessa with funds from government, has been strangely and culpably neglectful of this matter, though of vital importance to the country; for the bullock is here the only power employed in culture and in the carriage of produce. Nor have my applications, both in person and by letter, dated the 27th March, to General Federoff, the Governor of Bessarabia, and acting Governor-General of New Russia, been hitherto more productive, though his Excellency politely met my inquiries with promises to endeavour to satisfy them. My questions bore particu-

larly upon two points. 1*st*, On the progress of the contagion or epidemic, its course and direction; 2*dly*, On the mortality compared with the stocks of certain districts.

Fearing further delay, I now venture to lay before your Lordship the information, however imperfect, that I have obtained, chiefly from private gentlemen holding estates in different parts of the country, as well as from persons who, like myself, have been seeking it in various ways.

The disease has been called the Cattle or Siberian Plague. The grey-coloured breed, alone indigenous upon these steppes, is thought to be particularly subject to it, and many persons are assured that this country is never entirely free from it, though it may remain unnoticed during a long time, while inactive and restricted to obscure parts.

Under certain circumstances, some of which may be explained, the disease acquires great intensity, and, becoming violently contagious, spreads throughout the country. Thus, in 1829, an immense number of bullocks, accumulated beyond the Pruth, for the use of the Russian army in the war against Turkey, having perished from starvation through mismanagement, the cattle-plague immediately ensued. The mortality in the principalities alone, during the autumn of that year, exceeded 200,000 head; the entire stocks in Bessarabia were destroyed; and the provinces northward became infected, and suffered enormous losses. In 1837 the same disease again broke out, and caused a similar destruction of cattle throughout these parts. It is believed to have then first appeared in the Bondjak in Lower Bessarabia, where many thousand draught bullocks had been long detained without pasturage or other sufficient food around the salt lakes that are administrated by government.

In 1842 and 1843 the disease ravaged the Tchernamov country, to which it was confined, by severe measures on the Don and at Taman preventing all communication. No antecedent causes were there known, nor can any be assigned for the present outbreak, which was first observed in August last. Its original seat is believed to be Bessarabia, though the people of that province say the contagion was brought to them from Galicia, an opinion probably erroneous.

In 1829 the disease was first noticed in August, and it continued till nearly the approach of the following summer. In 1837 it began in September and lasted till May. The autumns of those years were very damp, and the winters remarkably severe. Last autumn was exceedingly dry, and the winter moderate, though long. The seasons and the temperature seem in no way whatever to affect the intensity or duration of this destructive disease. That it is supremely contagious, is universally believed;

but phenomena similar to those of the cholera have been observed, which seem to give it the character also of an epidemic.

The following description of the symptoms and course of the disease I believe to be very correct. It was given to me by an intelligent proprietor, and it has been confirmed to me by the evidence of many others.

The infected animal loses its appetite, and ceases to ruminate. It remains long motionless on its legs, which seem to be stiffened. The ears are cold and pendant; later, the eyes begin to water, and a slimy foam drops from the mouth. The beast becomes agitated, lying down and getting up often; little thirst; and the hair along the back is bristled up. At length, too weak to rise, it remains upon the ground moaning, the flanks heaving quickly, and with every appearance of cruel sufferings, that end in death. In most cases a dysentery, preceded by constipation, comes on at the second period of the disorder, with evacuations exceedingly offensive. The constipation does in some cases, however, continue to the end. On bodies being opened after death, aliments are discovered in the stomach and intestines agglomerated into a hardened mass, all the viscera in a state of high inflammation, and in some individuals a sanguine congestion towards the head, with the skin reddened by blood. The same authority states that the more vigorous animals are generally the first to be attacked, and that almost all of them die, whereas the weaker often recover. Cows, calves, and oxen, become infected without distinction of age; some sink under the disease within the first forty-eight hours, others on the third, fourth, or fifth day. The convalescence of the animals that recover lasts from twelve to fifteen days; during the first three or four they remain recumbent, without the power of rising. The cows that recover always lose their calves by abortion, and it is added that cows of an infected herd, without having sickened themselves, generally lose their calves also in the same manner. I have the honour of transmitting enclosed the translation of another account published in Russia by a German farrier in the service of this government, which contains a far more detailed description of the symptoms and progress of this disease; but though I have heard no part objected to by the experienced here, it is suspected to be the result of observations made elsewhere rather than in this country.

With respect to the medical treatment practised and recommended here, a great many modes have been cried up, of none of which the benefit is sufficiently authenticated to authorize their enumeration; and I have heard sensible and experienced men declare that the acuteness of the malady defies all remedies till now known. I presume, however, to make mention of one

of a very simple character that many assert has been found availing at the very first stage of the disorder, namely, a decoction of lintseed, first ground into a coarse flour, boiled in water with some nitre. The patient is to swallow a bottle of this in the morning and another at night, intestinal injections of the same being made in cases of costiveness.

The measures upon which all opinions agree are those that have in view the preservation from contagion. For this purpose the government of Austria has forbidden, since many months, the passage of Russian cattle across her frontiers. The Russian government took similar precautions upon the Don in 1842 and 1843, and the order is now everywhere enforced, that the dead bodies of infected cattle are to be buried immediately, and without subtracting the hides or any other part of them. So great is thought to be the contagious power of the cattle-plague, that dogs feeding on carrion may, it is said, convey the infection, as likewise herdsmen, by carrying along with them mephytic effluvia in their clothes. With greater reason is the ground considered to be contagious over which diseased cattle have passed, and even ponds and wells where they have been watered, on the surface of which the mucous discharges float like an oily substance. That cattle may be preserved from infection by the prevention of all dangerous contact has been proved in several instances known to myself, and I am told further, that on the separation of the sick from each other recoveries become more frequent.

I am intimate with a gentleman who holds a small estate near Akerman in Bessarabia, his lands resting by two sides on the Leinan of the Dniester and the sea. He was the more easily enabled to shut out communication with all stray cattle, in consequence of which his own stock was entirely saved, while that in the immediate neighbourhood nearly all perished; for in no other part of the country was the disease more violent.

I am acquainted with another person, with a large estate in the government of Cherson, who escaped loss by similar precautions. Previously to the breaking out of the disease, he had sold produce to be taken away by the purchasers, and rather than allow strange bullocks to come upon his grounds, he voluntarily undertook the labour and expense of the delivery upon an assigned and distant spot. I know a district in the Taurida that was entirely free from the disease till two yoke of oxen came with goods from a distant quarter to the estate of a lady. It broke out there a few days after, upon which the neighbouring proprietors, with the consent of all parties, instituted measures by which it was confined to that one place, where it soon wore itself out. These instances, and many similar, bear upon the power of con-

tagion, but there are others equally notorious, from which the same inferences cannot be drawn. An estate of 15,000 acres, about twelve miles from Odessa, was divided last year between three brothers. The share upon the high road was early infected, and of 85 head of horned cattle 32 quickly perished. The second share was not immediately attacked; for the disease went round and destroyed 800 in a Bulgarian colony, and a great number in other estates close to the back of it; and it was not till two months later that the infection reached that share, and carried off 25 beasts out of 80. But, strange to say, the third share has entirely escaped to the present day, though contiguous, and no precautions were taken in either case against communication, and its produce was carried to market without interruption. In the district of Yampol in Podolia, a large village upon one side of a small rivulet escaped infection, while another closely opposite lost its whole stock; and a third village, on the same side as the healthy one, and only a short distance lower down, was equally unfortunate. The disease sometimes seems to pursue a capricious course. It will also advance upon a direct track without spreading infection laterally; thus, it will ravage one-half of a village and leave the other free. It will then make a circuit, returning and attacking places that had remained uninjured. It will likewise come back to the same place twice or thrice. I have heard persons say that they lost their strong working bullocks, then their cows and calves, at different periods.

To trace the course of the disease upon the map, however desirable, cannot be attempted with any assurance, in the absence of official authority. I have said, and it is generally believed, that this time it originated in Bessarabia, whence, probably, it spread through the government of Podolia and Cherson, and then to Kiev and Volhynia. It is reported to have reached Mohilov, and that the central provinces of Karkoff and Poltava have not escaped the same infliction. In this latitude the infection has not extended so far eastward. The government of Ekatherinslov has only been partially affected, and the Vice-consul at Taganrog tells me that it has not been spoken of on the Don since 1843.

It is with still greater hesitation that I may speak of the extent of the mortality. On the one hand there may be exaggeration in private opinion; and on the other, were official returns even made known, they must be accepted with equal caution; for functionaries in Russia, by an instinctive policy, always attenuate the amount of public disasters, if by necessity they are confessed. For this reason no more than occasional hints are to be found in the provincial journals even of the existence of this disease in the shape of a farrier's prescription, yet I am assured that

the loss in Bessarabia by the end of last year was reported to be 130,000 head of cattle, and that since it has amounted to one-half of the whole stock. In the government of Cherson, in which this town is seated, the loss at the present day is estimated at one-third, which is confirmed to me by many proprietors. In two large estates on the Dnieper, the property of Count Woronzow, it is said that not less than 12,000 head have perished, of which 4,000 belonged to the lord, and the remainder to the peasants. In the Taluya estate of General Leon Vlarishken, the mortality exceeds 6,000 beasts. The head groom of the General had a choice herd of 50 milch cows, all of which have died, with the exception of one cow that lost its calf by abortion. A gentleman in the vicinity prided himself in the possession of a herd of 240 beasts of a coloured and foreign breed, and all of them have been carried off. Of similar instances in farther districts I shall venture to say nothing; but the number of cattle swept away throughout the country must be enormous. It is signified by the raised rates of carriage, and great difficulties are anticipated in all field labour. The prices of cattle have, however, not augmented; for no purchasers are yet bold enough to come forward.

In concluding this report, I am happy to be enabled to inform your Lordship that this most destructive disease is at present generally subsiding. Bessarabia is declared to be nearly free of it, and this neighbourhood is so entirely.

I presume to add that, on now referring to books, I find that the disease I have been endeavouring to describe seems to be identical with the murrain, that malignant epidemic which, during ages, has at different times ravaged various parts of Europe, with symptoms possibly modified by local causes.—I have, &c. &c. (Signed) JAMES YEARNES.

The following is the veterinary account of the symptoms of this disease referred to in the above letter.

Description of the Cattle-Plague, "Pestis Boum."

From the time of infection to the appearance of the first symptoms of this disease, six or eight days generally elapse, and very rarely is the contagion so strong that the symptoms appear two days only after that time. In ordinary cases, little alteration is to be discovered in the infected animals for the first three or four days; and its appetite even is rarely affected within that time. On the seventh or eighth day only are some febrile symptoms seen, such as the rising of the hair along the back, a great sensibility of the loins, an unusual indolence, weakness in the limbs, and staggering motions. Later, a dragging of the limbs, yawning,

and grinding of the teeth, with loud bellowing at times, and uneasiness. Soon after, greater signs of fever ensue—the nose and mouth become dry, the eyes dim, and the whites redden. Further on, rumination and licking of the face become languid and rare. Cows partly lose their milk, and a cough completes the full proof of the presence of the destructive malady.

This proof of the disease manifests itself on the seventh or eighth day, and, rarely waiting the eleventh or twelfth day after infection, is followed by a remarkable increase of febrile shiverings, mostly in the hind limbs, in the rising up of the hair along the back, and the frequent alternation of heat and cold on the skin. The uneasiness of the sick animal increases, and is signified by stamping, lowing, great trembling of the limbs, and by drawing the hind legs under the belly convulsively. The beasts, previously strong and well-fed, become furious, while the weaker, and calves, are more and more dull and languid, the eyes glisten and redden, and the nose is red, dry, and hot.

The gums and muzzle are now covered with red spots, and foam drops from the mouth. The red spots soon become white blisters, which, causing the skin to peel off, wounds, oozing blood, are discovered, and the skin at the corners of the mouth is puckered with an appearance of a white tallowy flesh.

The respiration quickens, and is deeper; the pulse is accelerated and weaker; the cough returns frequently and sounds low; all inclination to feed, as well as rumination and licking, entirely ceases. Cows lose all their milk, and great thirst is manifested. The animal now attempts in vain to hold off its tail from the body during its evacuations; and the fœces are in small quantity, dry, and black, as if burnt. The urine is reddish and clear; the eyes and nose, till now dry, begin to discharge, at first a watery, later a slimy matter, which is highly infectious.

The loins are so irritated, that, on the touch of a hand, the animal winces convulsively.

On the second or fourth day after the positive appearance of the disease, or on the ninth, tenth, or eleventh day from the time of infection, all the symptoms above described exceedingly increase.

The pulse quickens, so as to be no longer counted, the heart throbs violently, the rigidity of the skin becomes greater, and the animal falls off rapidly in flesh and strength, so that, in most cases, he lies down, or, if standing, staggers from side to side.

Spots already appeared become pustules, the discharge from the eyes more abundant and foul, forming in the corners and around, a scaly substance; that from the nose thicker, and the slime from the mouth more ropy; the tongue surcharged, and the breath most offensive.

Finally comes on a diarrhœa, with great efforts; the fœces voided emitting a stench extraordinarily fœtid, and very contagious, and dangerous to all cattle within reach of it.

The last stage is signified, not only by this diarrhœa, in which the intestines are protruded often, but likewise by the increase in the quickness of the respiration, and in pulsations of the heart, as well as of the several discharges.

These final symptoms appear generally on the twelfth to the sixteenth day after the time of infection, and are followed by death, with dreadful convulsions.

REPORT ON PLANTATIONS OF PINUS SYLVESTRIS, forming part of the FOREST of BALNAGOWN, the Property of Sir CHARLES ROSS, Bart.

By ROBERT GRIGOR, Esq., Invergordon.

[Premium, the Gold Medal.]

THE fir plantations of Lammington and Lairg form part of the extensive forests of Balnagown, in the shire of Ross, and are situated about three miles northward of the Bay of Cromarty. Adjacent to the bay, the land is of a light loam, lying on a substratum of gravel, incumbent on sandstone, and but little elevated above high-water mark. Towards the interior it rises gradually, and at a mile from the margin of the bay is a table-land 100 feet above the level of the sea. On this flat stands the castle of Balnagown. Within a few yards of the castle there is a deep ravine, which forms the outlet of the water of Scotsburn. On either side the ground rises very steeply, and on the side opposite to the castle we have the first proofs of a soil particularly adapted to the growth of the *Pinus sylvestris*. There are there several very fine specimens of that tree, of a great age and size, on a level, and which vie not unsuccessfully with the ancient castle on the other side. Though these trees stand at an average of twelve yards from each other, it is evident, from their bare stems, as well as from decayed roots, that, in former times, they must have been more crowded, and that the average distance between the trees must have been five yards. They are not, therefore, so remarkable for great girth as for their tallness and cleanness of stem. On an average, they girth upwards of 4 feet, at 7 feet from the ground; and one of the largest measures 6 feet 3 inches in circumference, at 1 foot from the ground, and, at 7 feet, 5 feet 4 inches in circumference. They are all without branches to a height of 30 feet, and at that height measure, on an average, 3 feet 4 inches in circumference. On

examining a root which had been recently cut, the reporter found the number of rings, or annual layers, to be ninety-four, which he considers to be about the age of these trees. It measured 4 feet 9 inches in circumference. The inner 45 rings composed the red or heart wood; the outer 49 rings the sapwood; and, measuring from the centre, the redwood stood 5¾ inches, the sapwood 3 inches, and the bark ¾ths of an inch. The herbage consists of *Festuca ovina*, *Festuca duriuscula*, *Oxalis acetosella*, *Plantago maritima*, and *Juniperus communis*. The surface-soil is composed of decayed foliage, forming a black peat earth three inches in depth, on a subsoil of brown sandy clay one foot deep, incumbent on strong stony clay resting on red sandstone. These trees, generally, have still a very healthy appearance; but none of them will improve much, and a very few are beginning to shew symptoms of decay. Each, on an average, contains 30 feet of solid timber, and is estimated at £3.

Passing these, and going a short distance farther north, the ground ascends sixty feet, and consists of ridges of gravel, with an open subsoil, covered with about twelve inches of a mixed peaty gravel. Still farther on, and at a descent of thirty feet, the ground is marshy and interspersed with bogs, where logs of fir-wood are excavated, fresh and of good quality. Northward of this for three-fourths of a mile, the ground, in general, rises gradually, (having a southern exposure,) and is covered with heath. The remains of a young wood of fir-trees, which had arisen from seeds wafted from the neighbouring woods, present rather a singular appearance, from the circumstance of this wood having been lately seized upon as *a common*, not by the neighbouring proprietors, but by cottars, who cut it down hurriedly, leaving stumps of large trees from one to three feet high, and which would still afford remuneration for a second cutting for fire-wood, or even wood pavement. Besides these, there are several scattered trees growing throughout the moor, and though stunted in some parts, the soil in general seems well adapted for the growth of firs; and the unfavourable aspect of the plants in these parts can only be accounted for by the want of draining, the subsoil being clayey and retentive. The surface soil is of a very sandy peat to the depth of about two inches, and some few patches of it are cultivated.

At the termination of this, and at a height of 180 feet above the level of the sea, we reach the first of those plantations which are to form the subject of the following report, viz.:—

Lammington Park.—This plantation consists of 1050 acres imperial; and, according to the best information within the reach of the reporter, was formed in the years 1774 and 1775,

The trees in it must, therefore, be (allowing for the age of the plants at the time of the planting) about seventy-one or seventy-two years of age. The ground on which they stand, forms the first and lowest of those hills which extend from the Moray Frith to the west coast of Scotland, and also forms a bulwark against the northern winds for the protection of the fertile land between it and the Bay of Cromarty. The hill extends from east to west, and this plantation covers its southern aspect.

As already stated, the lower part of it is 180 feet above the sea, from which point it rises to its summit northward, a height of 230 feet; making its greatest elevation 410 feet above the sea. Such being the case, and as the trees have grown well to the summit of the hill, although it does afford an opportunity of testing the growth of trees at different altitudes to a certain extent, it affords no opportunity of shewing to what altitude, in this quarter, the *Pinus sylvestris* may be profitably grown.

We shall now state, in their order, the supposed yearly value of the ground occupied by this plantation before having been planted; the mode of planting and after-management; the return which has already been yielded in thinnings, &c.; and the condition of the herbage and trees, accompanied with a statement of their present value.

1*st*, The yearly value of the ground before having been planted, and now, supposing it not to have been so.

From the nature of the soil, the agricultural cultivation of any part of it could not, seventy years ago, have been undertaken. In the present day, about 200 acres of the lower part of it might have been profitably reclaimed. Throughout the whole plantation (bogs excepted) the soil is well adapted for the growth of trees. At the lower part of the wood it consists, besides about an inch of decayed vegetable matter, of four inches sandy peat earth, on eighteen inches sandy clay, on from three to four feet red clay, followed by clayey gravel, resting on sandstone. Owing to the peat earth, the natural herbage is, and must have been, composed of heath (*Calluna vulgaris*,) with which it is surrounded in every quarter. The higher you advance, the clay gradually diminishes into a lighter earth, and the peat earth gets deeper, and the heath more rank and close, until, at the very summit, where the wood terminates, a peat-bog is reached of considerable depth. Considering, then, that, as it stood when planted, nothing but bare heath prevailed —that it could not have been of great value as a sheep-walk— and that no great rents were then given for game—we must conclude that the rent of the whole could not have exceeded £10 per annum; and supposing it had not been planted, at the present time it could not be valued as a sheep-walk and for game at a very great increase.

2*d*, The mode of planting and after-management.

The mode of planting this wood was that which was common, if not universal, in the district at the time. The plants were three years old, but whether they were one or two years transplanted, or had been transplanted in the nursery at all, has not been ascertained. From an old gardener, well acquainted with Lammington Wood, it has been ascertained that in those days Scots fir plants were seldom put out below three years old, the opinion having then been, that they were not fit to stand exposure at an earlier age, which, it need scarcely be said, now appears a fallacy; for it has long been found that large plants of the fir genus are only fit for particularly sheltered situations or rank herbage. The plants were put into the ground by women, who carried them in baskets, while a man with a pike, having a prong three-fourths of an inch square, with a tramp on it for the foot, made an incision in the earth to the depth of about six inches, and, by pushing the handle of it from him, and then drawing it smartly towards him, he extended the incision so as easily to admit the plant. The operation was completed by the man pressing with his foot the earth upon the root of the plant. It is evident that this mode must have been more tedious and expensive, and not more complete, than that practised with the hand-iron, which is at present reckoned the most successful method of planting moor ground.

As will be noticed in the sequel, great profit might have arisen from the draining of several parts; but throughout the whole there is not any symptom of such a thing having been thought of; nor, considering the period, is this greatly to be wondered at. Along the lower extremity of the wood there seems to have been built a turf-dyke, and the same at either end; while along the summit there are no marks of such, and there such may not have been required.

"After-management" there must have been none. The trees in the remoter parts of the wood are growing as they had been planted, without thinning, the stronger prevailing, but the whole greatly injured. In the more accessible parts, again, the larger trees had been cut down, not with the intention of thinning, but because they had been required; so that the wood, throughout the greater and better part of it, is too thin, and in the inferior parts too crowded.

This brings us to the next point for consideration, viz.

3*d*, The return which this wood has already yielded in thinings.

From the numerous extensive plantations on the estate of Balnagown, and from no separate account of each having been

kept, it is believed that no exact account of the revenue which this wood has already yielded exists. The only way, therefore, by which this information may be acquired, is by looking at the wood itself, and from it drawing the most probable conclusions. In the more remote parts, and, indeed, throughout the generality of the more elevated portion of it, the trees are so close, or the remains of them shew that they have been so close, as to warrant the assertion that the whole forest has throughout been a very regular and a very close crop. It is understood that a fair crop of Scots firs, at maturity, should stand 300 trees per acre, and in a few places in this wood they will do so. The general allowance of young plants to an acre is, in exposed situations, 4,800; while, in ordinary circumstances, 3,000 per imperial acre is reckoned sufficient, and it is worthy of remark that, in this plantation, this rule seems to have been adhered to, it being observable that the trees in exposed situations have been planted at three feet, while nearer the base they had stood about four feet apart. Of these, at forty years of age, there ought to have been about 450 standing. The nature of the soil, and everything connected with this wood, go clearly to shew that, at forty years of age, it had stood that number; but, that we may be rather under than above the proper mark, let us suppose 400 an acre at forty years old.

Of the best of the wood, there are 500 acres out of the 1050 which do not now average more than 140 trees, and we have counted some acres on which there are considerably fewer. The difference between 140 and 400 is 260, being the number of trees thinned out per acre, and which, from the appearance of the roots, may be estimated as having been cut as follows:—

Taken out Yearly when the Plantation was of Age—

From 40 to 50 years—60 trees per acre imperial, at 1s. 6d.,	.	.	L.4	10	0
„ 50 to 60 „ 80 „ „ 2s. 6d.,	.	.		10	0	0
„ 60 to 70 „ 120 „ „ 5s.,	.	.		30	0	0
Making per acre,	.	.	.	L.44	10	0

which, being multiplied by 500, the number of acres above specified, gives, ... L.22,250 0 0

Of inferior parts there are 400 acres, out of which a considerable quantity has been taken, and which is estimated as follows:—

Taken out Yearly when the Plantation was of Age—

From 40 to 50 years—20 trees per imp. acre, at 9d.,	L.0	15	0
„ 50 to 60 „ 35 „ „ 1s. 6d.,	2	12	0
„ 60 to 70 „ 35 „ „ 3s.,	7	10	0
Making per acre, . .	L.10	17	6

Carry forward, L.22,250 0 0

Brought forward,	L.22,250 0 0
which, being multiplied by 400, the number of acres above specified, gives	4,350 0 0
Of wood which never has been thinned, including bogs, &c., there are 150 acres—amount realized, ...	0 0 0
Making the gross return from this plantation already received,	L.26,600 0 0

For *thinnings*, these prices, at an oversight, may be considered too high; but it must be borne in mind that that word, in its ordinary acceptation, cannot be applied to these trees; for the "thinnings" above valued were not the worst, but the best of the timber. This is apparent from the size of the roots, which shew that, in general, the trees cut must have been larger than those standing, and that in reality the thinnings are those left. For example, a root cut ten years since (the period is ascertained by its appearance, and by counting the annual rings of it,) measures 3 feet 4 inches in circumference, while, *even now*, the largest of twenty-one trees surrounding it measures 2 inches less. This is an ordinary case, cited to shew the data on which the above opinion is formed.

4th, The nature of the soil and subsoil, and herbage, and present condition of the trees.

In stating these, we shall first offer a few remarks on the eastern and then on the western division of the plantation, so as to exhibit a fair view of the whole.

At the lower part of the eastern end the soil consists of six inches of sandy peat, on a subsoil of twelve inches loam, incumbent on clay. Till very lately, the trees have been so close as to prevent any herbage whatever from growing; and there is nothing to be seen save the decayed leaves and mosses, with scattered plants of heath, which are only beginning to grow where the greatest openings have been made. Though the trees here appear perfectly healthy in colour, it is evident, from the short growths which they have lately made, that they would improve very little; and this is confirmed by the evident decay which appears in other parts of the wood, and which shall be noticed hereafter. The largest trees here do not exceed 17 inches in diameter. One has been selected as a fair criterion, the proportion of red or heart wood in which is $2\frac{3}{4}$ inches on the half of the diameter, (*i. e.* measuring from the centre,) containing 31 rings or annual layers; sapwood $3\frac{3}{4}$ inches, 21 rings; ditto $1\frac{1}{4}$ inch, 18 rings; and the bark $\frac{3}{4}$ths of an inch. Here the sapwood is divided to shew that the tree made the most rapid growth during the twenty years of its age from thirty-one to fifty-one. This is not attributed to the roots having got into better soil, but to the circumstance of the tree having been then in its prime; and the fact of its only having grown $1\frac{1}{4}$ inch during the last eighteen years, the outer rings

being so close that they can scarcely be counted, shews that it may be considered as at full maturity. With very few exceptions, the bulk of the growth is towards the south, the rings being wider and more easily counted than in the north side of the tree; and where there are exceptions, they are satisfactorily accounted for by the exposure. For instance, a tree measuring 16 inches diameter, measured from the heart northward $3\frac{1}{2}$ inches redwood, containing 29 rings; $6\frac{1}{2}$ inches sapwood, containing 42 rings, with $\frac{1}{2}$ inch bark. Towards the south it measured 2 inches redwood and 3 inches sapwood. One yard southward from where this tree stood, there is an old root, and two yards farther, another; while to the north there is a semicircle of five old roots at seven yards distance. Near this the ground has been excavated to the depth of eighteen feet, with the view of procuring water for a steam-engine, which was to have been erected for the purpose of manufacturing part of the wood, (the whole of which had been sold as after mentioned,) and an opportunity is thereby given of inspecting the soil to that depth. It is composed of twelve inches sandy peat, resting on sandy clay interspersed with some pieces of sandstone, incumbent at that depth on sandstone rock, and no water has been procured. Here the trees are of good quality and of large size, many of them measuring six feet in circumference, and average twenty-two feet apart. Throughout the whole extent of wood there is not the appearance of a spring of water.

As we ascend the hill a little eastward, and at no great distance, we reach the margin of a bog of three acres, where none of the trees exceed 9 inches in diameter at the surface, and where the generality are stunted shrubs of 4 inches diameter. The soil is of fully as good quality as that which surrounds it; and, from the elevation of it, draining would have been very easily effected. Here the heath is rank, and thickly interspersed with lichens, with which the trees are covered. It is thought that the increased value of three trees would have been equal to the expense of draining the three acres.

Immediately beyond this bog, and so near that, until the nature of the soil is taken into view, one almost wonders that a bog should there be found, is a steep declivity of a few yards, with trees nine feet apart—the largest, 40 inches circumference at 1 foot from the surface, but the average of which is 20 inches circumference. From their proximity to the bog, and a northern exposure, they are covered with lichens. From their age, no profitable improvement could be made on them now. Passing a morass thirty-two yards broad, with a few self-grown firs of small size, we reach a slope having a southern exposure. A very little above the morass, and not so high as the bog, on the opposite

side, there is some very fine timber growing, at an average distance of five yards apart. The heath is rank, but not close, and is intermixed with mosses and a few plants of *Erica tetralix.* The soil is composed of four inches sandy peat, three inches sandy mould, four inches lighter, but looking richer, and a considerable depth of soil more resembling clay.

Through the kindness of the most extensive purchasers of this wood, Messrs A. and G. Paterson of Glasgow, we have been enabled to send herewith sections of a considerable number of the trees, the first of which is that of one of the largest trees that grew here, and which is sent as being a fair average specimen of the best of the timber in this plantation.* This tree measured in circumference 5 feet 7 inches; and at 22 feet high, 3 feet 9 inches. Its extreme height was 64 feet. The average of the trees on this bank measures 4 feet 3 inches at the surface. Here the height above the level of the sea is estimated at 310 feet.

A little farther up and another bog appears, on a level of six acres or thereby, which is still more wet than the other, and the trees smaller and more irregular. It occupies the centre of a large flat, which throughout is swampy. The mosses prevail amongst the heath, (*Calluna vulgaris,*) accompanied with lichens, which also appear on the trees. The soil is five inches peat, upon a subsoil of ten inches grey sandy earth, incumbent on a brown rusty pan or crust. On this flat the average distance of the trees apart is twelve feet. Their average size is 3 feet 4 inches circumference at one foot from the surface; and the largest tree, which has had considerably more space than the others, measures 5 feet at the surface and 4 feet 2 inches at 6 feet. This tree is branchy topped, and at 18 feet from the ground the circumference of the trunk is 27 inches. Farther north, and nearly on the same level, is another concavity and morass similar to those described; but from it the ground, on the other side, rises with a southern exposure more rapidly, and takes more the form of a knoll. On this grows some very fine timber—not so large as in some other parts, but of as good quality and more cleanly grown. The soil is similar to that last mentioned, but, from its elevation, it is drier than the surrounding ground. Up to a recent date, it has borne a very heavy crop, and the decayed foliage lies so closely amongst the decaying roots as to prevent even the heath from gaining a footing. What herbage there is consists of heath and mosses. Here there grew a tree of which a section is sent, which shews the advantage of a southern exposure, especially when taken in connexion with an open space. We have already given the dimensions of the growth of a tree which had been confined towards the

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* These sections may be seen in the Society's Museum in Edinburgh.—Ed.

south with sufficient space towards the north. This tree had grown in circumstances the reverse of these. It was confined to the northward by a tree within seven feet of it. To the east there grew a large tree at a distance of nine feet. On the north-west, at fifteen feet distant, another; and immediately to the west none. As will be seen by the section sent, the diameter of the tree, southward of the heart, is 10 inches, while to the north it is only 5. The particulars of the measurement of it are—circumference at 1 foot from surface, 4 feet; at 7 feet, 39 inches; at 17 feet, 33 inches; at 24 feet, 29 inches; and at 36 feet, 25 inches. From 24 to 36 feet very branchy. At 17 feet high the heart of the tree was in the centre of it. Of the tree which grew immediately to the north, and within seven feet of it, a section is also sent. It presents no peculiarity beyond the comparatively small size, and close grain, and thick bark; being "evenly grown," although it had eighteen feet space to the north and only seven to the south. The fact of the hill rising to the north counterbalanced this. The dimensions of it are—circumference, at 1 foot high, 2 feet 10 inches; at 10 feet, 2 feet 3 inches; and at 16 feet, 1 foot 11 inches. Branches few. The soils last mentioned are similar to those on which these trees grew.

Beyond this knoll the timber occupies a higher elevation and is on wetter soil, and, from the latter cause, it is small. Still higher, and along the eastern shoulder, there is a considerable portion of it still more injured by wet, which is all surface water, and which might have been very easily drained. Had this been done, few parts of the wood would have been better. The soil in general consists of three inches peat on ten inches sandy mould. The trees measure 3 feet at the surface of the ground, and 2 feet 3 inches at 6 feet. The heath is close and rank, and is interspersed with mosses and lichens, the latter of which cover the trees. A section sent, measuring 1½ foot in circumference at 12 inches from the surface, is of one of the trees in a wet place, and where the neighbouring trees did not encroach upon it.

Having thus gone over the eastern division, let us turn to the other, part of which occupies the highest ground.

Beginning, then, as in the former case, at the lower extremity of the wood, and taking our course to the highest summit of it, we find that the trees on the whole stand closer, and on soil considerably hard and nearer the rock, and very much of a description suited to larches. It may be observed, in passing, that there are no larches in this plantation. There being no peculiarity observable, the first tree cut was near the western extremity, and about 200 yards from the side. It is an average tree, and is a fair specimen of the bulk of the wood at that place. The herbage is very similar thoughout the whole wood, and scarcely

ever did the reporter see a wood in which there was less variety. Heath and mosses are the sole occupants; and this sameness is accounted for, not so much from a want of variety of soil, and particularly of subsoil, as from the age of the wood, the great quantity of trees grown in it, and the consequent thickness of decayed foliage, which is pernicious to almost everything else, taken in connexion with a thin layer of peat-earth that runs throughout the whole extent of it. A section of this tree is forwarded measuring 4 feet 1 inch in circumference. At 24 feet, the tree measures 2 feet 9 inches. The soil consists of three inches of peat, on two inches of very sandy peat, and five inches of light hard mould, incumbent on sandy clay, and is pretty steep.

The largest tree in the whole forest, of which we have been unable to procure a section, is in this vicinity. The trunk is short, and breaks up into a branchy top. Its girth at 1 foot from the ground is 8 feet 6 inches. Its size is attributed to its having enjoyed an open space, and to the form it has taken.

Farther up, the ground is less steep and softer, having a declivity of 1 in 15. The heath is closer and ranker than in the lower ground, and the mosses are stronger. From this was produced a tree whose section is sent, grown upon three inches of peat, eight inches of sandy peat, and eleven inches of soft dun sand mixed with stones.

This section is decayed in the centre, which indicates a soil unsuited for producing Scots fir timber of great size or age. At various parts of the wood we have observed slight appearances of similar decay, but here the trees shew more obvious marks of it than at any other place, and the section sent is the worst that was seen. The trees are bushy and flat on the top, and making little growth. This section is of a tree rather smaller than the average. It measures in circumference 2 feet 4 inches, and grew about 250 yards from the tree whose section is mentioned as the fifth, and at an elevation of 20 feet above it. The top-shoot of this tree grew 15 inches during the last six years, and the whole trees here, although many of them are not rotten in the centre, as this section is, shew a stinted appearance. The average distance between the trees is 12 feet.

The situation does not vary from that where large and sound timber is abundantly to be found; and it is our opinion that this decay arises from the soil being deficient in some good quality.

At an altitude nearly approaching the highest point of the plantation the trees are to be met with at their original distance of about three feet apart. Some are dead, having been

choked at a height of from 8 to 12 feet. The survivors are tall and of small girth, and do not exceed one-half the value they would have yielded had they been judiciously thinned.

The wood continues thus till the summit, and the section sent was grown on the highest point of this plantation, and on soil consisting of a few inches of peat earth; the subsoil is sandy peat incumbent on red sandstone. This tree occupied a favourable situation, and is better than the average. It measures in circumference 4 feet 2 inches.

The plantation terminates precipitately on the very ridge or summit of the hill, there being no planting to the north at this end. The soil gets into a deep peat, and is surcharged with water. The trees, composing a belt along the ridge, have a very stunted and weather-beaten appearance, being covered with lichens, and having all their branches blown to one side, from a direct exposure to the north. At another point along this summit, and where the ground is drier, the trees seem to withstand the blast better. They measure 3 feet in circumference, and are about 18 feet high. Within forty or fifty yards of the summit, the trees, all along, attain a fair size. Here common fern forms part of the herbage, and some of the trees measure 5 feet in circumference at the ground.

The principal point in regard to this plantation remaining to be noticed, is that of the present value; but as it was recently exposed to sale in lots, some of which are connected with the Lairg plantation already named, we shall first offer our remarks on it, and then state the number of trees of different sizes which each lot contains, the price at which each tree was sold, and the total amount both plantations realized.

Lairg Plantation.—This plantation was formed about two years after that of Lammington. It occupies part of the northern exposure of the same hill, and extends to about 150 imperial acres. The declivity on which it stands averages about one in two, and its altitude is between 150 and 300 feet above the level of the sea. Being the property of the same proprietor as Lammington, Sir Charles Ross, Baronet, and, consequently, under the same management, the mode of planting and after-treatment have been very similar to those practised there, and the principle of the calculations applicable to the thinning of the former plantation applies equally here; but, from the wood being in general smaller than at Lammington, there had been a greater difficulty in getting large wood, and it is, therefore, if anything, still more evident that the largest and best trees have been thinned out, and the smaller only have been left.

The following is a state of the supposed return which this plantation must have yielded :—

Trees taken out of ages from 40 to 50 years—25 per acre, at 10d.,	L.1	0	10
— — 50 to 60 — 56 — at 2s.,	5	12	0
— — 60 to 70 — 80 — at 4s.,	16	0	0
Making per acre,	L 22	12	10
which, being multiplied by 150, the number of acres stated, gives,	L.3,396	5	0

On the ground before planting no value whatever can be put; because, from the remoteness of the situation, and the barren nature of the pasture, there is no probability that it would have been worth anything.

Towards the highest point of this hill, and along some spots surcharged with water, it is apparent, from the small size of the trees, which saved them from being removed, that they had been originally planted at 3 feet apart, while those along the bottom of the hill have been inserted at about 4 feet apart. The surface soil is throughout black peat, running into a hard sandy bottom, very retentive; but, from the rapid declivity, water does not seriously injure the trees, except in a few spots. As already stated, the most valuable portion of this wood was formerly disposed of. Herewith is sent a fair specimen of the size and quality of the largest trees remaining. In general, as with this section, the growth of the trees goes to the hill or south, and not to the north, which, so far as relates to exposure, tends to controvert the received opinion that trees, having a northern exposure, grow best; and, though the best trees here have been cut, yet there is enough to prove that the trees here (making allowance for difference in age) have not attained so great a size as those having a southern exposure in Lammington plantation; which, however, is accounted for, apart from climate or exposure, by the soil being of a decidedly inferior quality. The herbage is composed of heath, common *Vaccinium*, and the mosses, in addition to the more common varieties of which we may specify *Polytrichum commune*.

In reporting on the present value of these plantations, we have had the advantage of ascertaining their exact worth. On the 7th of June 1844, they were exposed to sale by public roup in eight lots, which lots comprehended both plantations reported on, and extending in all to 1200 acres. After a fair competition, amongst sixteen or eighteen wood-merchants and railway contractors, they were knocked down to six purchasers at the aggregate sum of £13,630.

The following state shews the amount which each lot brought—the number of trees of different sizes which we have ascer-

tained each lot contained on the day of sale, with the valuation of each tree *effeiring to the purchase price.* In classifying these trees, we have put them into three sizes, viz:—

Large Timber.—Trees containing 11 cubic feet and upwards.

Square Timber.—Trees containing 4 and under 11 cubic feet.

Small Timber.—Trees useful, and under 4 cubic feet.

LOT 1.—	4,420 Large timber,	at 4/9½ per tree,	L.1059	7	7½			
—	9,355 Square do.,	at 2/4¾ —	1121	1	11¾			
—	18,000 Small do.,	at /4¾ —	359	10	4¼			
	This lot sold for					L.2,540	0	0
LOT 2.—	3,405 Large timber,	at 7/5 per tree,	L.1265	19	4¾			
—	4226 Square do.,	at 3/8½ —	785	12	1¾			
—	10,600 Small do.,	at /7¼ —	328	8	5			
	This lot sold for					2,380	0	0
LOT 3.—	3,940 Large timber,	at 7/7½ per tree,	L.1503	14	1			
—	4,562 Square do.,	at 3/9¼ —	870	10	11			
—	11,500 Small do.,	at /7½ —	365	14	11½			
	This lot sold for					2,740	0	0
LOT 4.—	2,554 Large timber,	at 6/5¾ per tree,	L.828	2	10½			
—	2,501 Square do.,	at 3/2¾ —	405	9	7			
—	11,500 Small do.,	at /6¼ —	136	7	6			
	This lot sold for					1,370	0	0
LOT 5.—	1,578 Large timber,	at 7/5¾ per tree,	L.591	6	7½			
—	1,861 Square do.,	at 3/8¾ —	348	12	6¾			
—	3,842 Small do.,	at /7¼ —	120	0	9¼			
	This lot sold for					1,060	0	0
LOT 6.—	1,901 Large timber,	at 6 7½ per tree,	L.631	13	0¾			
—	3,105 Square do.,	at 3/3¾ —	515	17	1¼			
—	5,146 Small do.,	at /6½ —	142	9	9½			
	This lot sold for					1,290	0	0
LOT 7.—	1,812 Large timber,	at 6/1½ per tree,	L.554	18	11½			
—	5,390 Square do.,	at 3/0¼ —	825	7	6¼			
—	11,350 Small do.,	at /6 —	289	13	5¼			
	This lot sold for					1,670	0	0
Lot 8.—	849 Large timber,	at 6/10¼ per tree,	L.291	2	10¼			
—	1,418 Square do.,	at 3/5 —	213	2	8			
—	1,600 Small do.,	at /6¾ —	45	14	5½			
	This lot sold for					580	0	0
	Total,					L.13,630	0	0

Thus shewing that these plantations of 1200 imperial acres have realized the following sums:—

Lammington Park—in thinnings,	L.26,000	0	0
Laird Wood do.,	3,396	5	0
	L.29,396	5	0
To which add amount of roup-roll of 7th June 1844, as per preceding statement,	13,630	0	0
Making a total of	L.43,026	5	0

or £35 : 17 : 1¼ per acre, besides interest on the amount realized for thinnings, which is much more than equivalent to the

expense of planting and interest thereof down to the present day.*

Respecting the difference which exists in the health and quality of the trees in different parts of these plantations, the reporter has to observe that the prevailing defect (besides a want of thinning in some parts) causing a difference in the health, quality, and size of the trees, is stagnant water or want of draining, there being no drains, as already noticed, in any part of these extensive plantations. Notwithstanding this, it is remarkable to find a plantation, extending to upwards of a thousand acres, with so small an extent injured from the want of this important operation. This, however, is in a great measure accounted for by the surface in general being regularly inclined, and also by the fact that a forest, when once established, has the effect of drying the ground by absorption, and of keeping it dry by evaporating the showers and dews that fall upon the trees.

Although the timber in general does not exhibit that thickness of red heartwood which is so much appreciated in fir timber, yet, on account of its being firm and close-grained, and very resinous, it is of a quality very far superior to the generality of wood shewing so little heartwood. As far as the reporter can judge, these woods are composed of one kind of *Pinus sylvestris*, and though the timber is considered less degenerated, and better than the quality of timber of *Pinus sylvestris* usually cultivated in the low country, it is neither equal to what he has seen in the native Highland forests, nor is it reckoned equal to the first crop therefrom. It is, therefore, thought that these woods are a *second* crop; and this is more likely, from the circumstance of its being understood that they were produced from seeds collected on Balnagown estate, and that a plantation existed in the vicinity of Balnagown Castle, of which the trees there formerly mentioned are the remains, and in which the characteristics of the red Highland pine are more legibly depicted.

We may be excused for adding, in conclusion, that the subject of this report must afford great encouragement to the possessors of moor-ground, and must stimulate that spirit for planting which we are glad to see so boldly evinced by our northern proprietors. They seem to be fully imbued with a sense of the importance of planting, and that it is the best means of embellishment, at the same time that it is a sure source of wealth, and that it is not mere tinsel work, to be carried on only on the southern exposure of our hills, and under the windows of our mansions.

When standing on the western summit of Lammington wood,

* These woods thus yielded a rent of 10s. 3d. per acre for the ground they occupied for 70 years.—Ed.

and looking down through its narrow openings, we could not but admire the beautiful Bay of Cromarty—the seat of the descendant of the Earls of Cromarty—the princely castle of that extensive planter, Sir Charles Ross—and the lovely and fertile country by which these are surrounded. Nature has done her part, and has given a harbour in which the British navy might safely ride, with mountains for its bulwarks. Art and enterprise have taken advantage of it, and that bay bears upon its bosom the traffic of many merchants. All is beautiful; and nought to be seen but the blue waters, the fertile fields, and, up to your feet, the wavy woods. Turn—and why should this be the boundary of "civilization?" Why an apparently interminable extent of unvarying sterility, bounded only by its sister ocean, without one solitary tree upon which to rest the eye? Are the undulations of the waste not to be explored and turned to account, merely because the profits are more speedily realized by those who traffic on the ocean? No, our northern propietors practically evince their consciousness of the fact, that the hazard of planting is nothing, and the profits certain; and, we are glad to think, from the spirit to which we have alluded, that, at no distant day, the Scots fir shall rise on the very crest of these hills.

ANALYSES OF SOILS IN THE DISTRICT OF TURRIFF, ABERDEENSHIRE.

By John Shier, Esq., LL.D., Fordyce Lecturer on Agriculture, Marischall College, Aberdeen.*

In the statement which accompanied the tabular results and observations on the experiments instituted by the Turriff Agricultural Association there has already appeared an account of the geological character and relations of the soils of the district.

The textural examination of soils is useful in conveying to strangers, who have only an opportunity of reading an account of these experiments, the information necessary for recognising and naming any of these typical soils, according to recent classifications; and it also serves to afford an accurate idea of the

* Communicated by the Turriff Agricultural Association. The Report which the Association sent on Special Manures, and which appeared in the last number of the Society's Transactions, was drawn up by Mr Alexander Murray, Nether Mill of Cruden, Turriff, Aberdeenshire.—Ed.

state of division of the matters of the soil on which so much connected with skilful management and cultivation depends.

Of the terms used here, it is necessary to give the following explanation:—By impalpable matter is meant *clay*, or matter in so fine division of parts as to be capable of remaining suspended in water for more than a minute and a-half. The coarser parts are ranked under the names of *fine sand*, *sand*, *grit*, and *small stones*. The first of these passes through a sieve of muslin of 100 threads to the inch; the second is retained by the muslin sieve, but passes through a wire gauze one of forty threads per inch; the third is retained by the forty-thread sieve, but passes through one of ten threads per inch; and the last is retained by the ten-thread sieve.

The soluble matter of the soil is important as affording an idea of the matters most available to plants, and also most liable to be washed out of very porous soils. It has, moreover, an important bearing on the *questio vexata* of the source of carbon in plants.

The impalpable matter of the soil deserves the greatest attention, partly from its textural importance, and partly from the fact that its fine state of division brings it most extensively in contact with the spongioles of plants, and most effectively under the control of decomposing influences.

In the analysis of the impalpable portion freed from organic matter by ignition, the necessity of operating on several separate portions has the disadvantage of bringing out results in which the range of excess and deficiency is extended. This, however, can surprise no one accustomed to these investigations.

On a course of experiments to be continued during a rotation, and such alone can be generally instructive under the present system of agriculture, conclusions connecting the composition of the soils, manures, and produce, can only be collected at its close, and after an analysis of the produce. A few salient points, however, appear at this stage to demand notice particularly as suggestive of continued and more minute observation.

1°. That important and interesting results would follow more extended textural examinations of soils. This does not appear so fully from the Turriff district soils as it does when they are compared with the clayey and alluvial soils of the adjacent districts.

2°. That the quantity of soluble organic matter contained in some of these soils is far from inconsiderable, and strongly suggests the propriety of a general examination of the water from ditches, and from the drains in thorough-drained land. The subsoils, although the specimens were taken from considerable

depths, are by no means so devoid of organic matter as has generally been supposed.

3°. All the soils examined, when compared with soils of more recent geological origin, contain a *small* proportion of calcareous matters.

4°. The quantity of soluble salts in the subsoil at Rothie-brisbane is, for an open soil, unusally large, and is probably connected with the texture of the subjacent rock, and the facility with which that rock decomposes. It would be interesting to ascertain what are the prevailing weeds of this and similar soils, and how forest trees thrive in them.

5°. The large amount of alkalis existing as silicates in the impalpable or clayey matter is important, as confirmatory of an interesting observation of Dr Fownes.

I.—*Analyses of the Soil and Subsoil from the Experimental Field at Rothie-brisbane.*

1. Textural Analysis of the Soil, dried in air at common temperatures.

Water,		3.30
Organic Matter,		7 30
Carbonate of Lime,		.12
Impalpable Matter,		22.48
Fine Sand,	27.55	
Sand,	5 80	
Grit,	16.35	
Small Stones,	16.60	
Loss on sifting,	.50	
		66.80
		100.00

2. Chemical Analyses of the Soil and Subsoil.

(1.) *Soluble Matter.*

Soil.—100 parts of the soil, dried in air at ordinary temperatures, afforded to cold water .15 of soluble matter, consisting of—

Organic Matter,	.076
Inorganic Matter,	.074

the latter consisting principally of sulphate of lime, with a trace of alkaline chloride.

Subsoil.—100 parts of the subsoil, dried in air at ordinary temperatures, afford to cold water .364 of soluble matter, consisting of—

Organic Matter,	.086
Inorganic Matter,	.278

the latter consisting of earthy and alkaline chlorides, with a little sulphate of lime.

(2.) *Impalpable Matter.*

100 parts of the washed impalpable matter, dried at ordinary temperatures, consisted of—

	Soil.	Subsoil.
Moisture separable by drying at 300° Fahr.	2.3	1.6
Matter destructible by ignition, principally Vegetable,	11.1	4.75
Inorganic Matter,	86.6	93.65
	100.00	100.00

100 parts of the ignited impalpable matter yielded, on analysis, the following results:—

	Soil.	Subsoil.
Silica,	62.38	64.38
Alumina,	20.78	22.07
Lime,	.84	.89
Peroxide of Iron,	8.69	5.89
Oxide of Manganese,	2.75	2.47
Magnesia,	.68	.35
Potash,	1.28	1.37
Soda,	2.06	.94
Phosphoric Acid,	.13	trace
Loss, &c.,	.41	1.64
	100.00	100.00

II.—*Analyses of the Soil and Subsoil from the Experimental Field at Findon.*

1. Textural Analysis of the Soil, dried in air at common temperatures.

Water,		3.50
Organic Matter,		10.70
Carbonate of Lime,		.07
Impalpable Matter,		23.78
Fine Sand,	27.23	
Sand,	9.15	
Grit,	16.50	
Small Stones,	8.62	
Loss in sifting,	.45	
		61.95
		100.00

2. Chemical Analyses of the Soil and Subsoil.

(1.) *Soluble Matter.*

Soil.—100 parts of the soil, dried in air at ordinary temperatures, afforded to cold water .101 of soluble matter, consisting of—

Organic Matter,	.067
Inorganic Matter,	.034

the latter consisting chiefly of alkaline chlorides, with a little sulphate of lime.

Subsoil.—100 parts of the subsoil, dried in air at ordinary temperatures, afforded to cold water .063 of soluble matter, consisting of—

Organic Matter,	.050
Inorganic Matter,	.013

the latter, consisting principally of sulphate of lime, with a trace of alkaline chlorides.

(2.) *Impalpable Matter.*

100 parts of the washed impalpable matter, dried at ordinary temperatures, consisted of—

	Soil	Subsoil
Moisture separable by drying at 300° Fahr.,	4.60	4.44
Matter destructible by ignition, principally Vegetable,	16.14	8.92
Inorganic Matter,	79.26	86.64
	100.00	100.00

100 parts of the ignited impalpable matter yielded, on analysis, the following results:—

	Soil	Subsoil
Silica,	67.08	59.95
Alumina,	20.20	22.79
Lime,	1.41	1.19
Peroxide of Iron,	8.08	9.18
Oxide of Manganese,	1.24	.82
Magnesia,	.35	14
Potash,	1.36	2.19
Soda,	1.64	44
Phosphoric Acid,	trace	—
	101.36	96.61

III.—*Analyses of the Soil and Subsoil from the Experimental Field at Slap.*

1. Textural Analysis of the Soil, dried in Air at common Temperatures.

Water,		2.7
Organic Matter,		7.4
Carbonate of Lime,		.20
Impalpable Matter,		34.94
Fine Sand,	23.80	
Sand,	5.70	
Grit,	11.30	
Small Stones,	14.38	
Loss in sifting,	.57	
		55.75
		100.00

2. Chemical Analyses of the Soil and Subsoil.

(1.) *Soluble Matter.*

Soil.—100 parts of the soil dried in air, at ordinary temperatures, afforded to cold water .154 of soluble matter, consisting of—

Organic Matter,	.111
Inorganic Matter,	.043

the latter consisting principally of sulphate of lime, with a little alkaline chlorides.

Subsoil.—100 parts of the subsoil, dried in air at ordinary temperatures, afforded to cold water .088 of soluble matter, consisting of—

Organic Matter,	.068
Inorganic Matter,	.020

the latter consisting of sulphate of lime, with a trace of alkaline chlorides.

(2.) *Impalpable Matter.*

100 parts of the washed impalpable matter, dried at ordinary temperatures, consisted of—

	Soil.	Subsoil.
Moisture separable by drying at 300° Fahr.,	4.24	4.83
Matter destructible by ignition, principally Vegetable,	11 87	7.77
Inorganic Matter,	83.89	87.40
	100.00	100.00

100 parts of the ignited impalpable matter yielded, on analysis, the following results:—

	Soil.	Subsoil.
Silica,	65.28	57.39
Alumina,	21.78	22.50
Lime,	1.24	1.01
Peroxide of Iron,	7.18	13.36
Oxide of Manganese,	3.09	1.33
Magnesia,	.21	.01
Potash,	.55	.38
Soda,	1.43	.98
Phosphoric Acid,	.14	trace
	100.90	97.04

IV.—*Analysis of the Soil from the Experimental Field at Stonewell.*

TEXTURAL ANALYSIS, DRIED IN AIR AT COMMON TEMPERATURES.

Water,		2.70
Organic Matter,		6.50
Carbonate of Lime,		.12
Impalpable Matter,		25.33
Fine Sand,	25.60	
Sand,	14.13	
Grit,	21.45	
Small Stones,	3.40	
Loss in sifting,	.77	
		65.35
		100,00

V.—*Analysis of the Soil from the Experimental Field at Lower Cotburn.*

TEXTURAL ANALYSIS, DRIED IN AIR AT COMMON TEMPERATURES.

Water,		3.50
Organic Matter,		6.80
Carbonate of Lime,		.10
Impalpable Matter,		23.28
Fine Sand,	24.42	
Sand,	4.67	
Grit,	9.63	
Small Stones,	27.55	
Loss in sifting,	.05	
		66.32
		100,00

REPORT OF EXPERIMENTS WITH DIFFERENT MANURES ON HAY, POTATOES, CORN, AND TURNIPS, IN 1844; with Observations on their continued Effects on the succeeding Crops.

By Mr JOHN WILSON, Junior, Eastfield, Penicuik, Mid-Lothian.

Hay.—The ground consisted of four acres, which were divided into sixteen portions of a rood each. Nine different manures were used, seven of which were applied at two different places, and the other two, for want of sufficient room in the field, were applied to only one portion each.

The field has a gentle declivity, with a southern exposure; the soil is what is termed a thin upland clay, resting on a clay subsoil, and was drained about four years ago at thirty feet apart; but, to render it thoroughly dry, it would require intermediate drains. To have the ground as nearly as possible of the same quality, the field was divided into oblong portions in the same direction, and of the same breadth as the distances between the drains, so that each portion had the benefit of one drain.

It may be proper to state that, although the ground is as nearly as possible of the same quality, and its previous management in regard to manuring and cropping the same, yet it will be observed on perusing the following table, that the crop on the west side of the field was better than that on the east. The only reason I can adduce for this is, that, previous to the sowing of the grass-seeds, the east side was ploughed in February, and the west not until March, immediately before the seeds were sown; but, as this difference in the time of ploughing, and the

results arising from it in the weight of the crop, took place exactly between the two sets of experiments, no error will be made from considering both portions of land of the same quality, and although the crop of one-half of the field was superior to the other, the substances employed acted nearly in an equal degree in each.

The substances employed in one set of experiments were—

1. Urine.
2. Rag-Ley.*
3. Soot.
4. Saltpetre.
5. Nothing.
6. Nitrate and Sulphate of Soda.
7. Common Salt.
8. Guano.
9. Nitrate of Soda.

In the other set they were—

3. Soot.
4. Saltpetre.
5. Nothing.
6. Nitrate and Sulphate of Soda.
7. Common Salt.
8. Guano.
9. Nitrate of Soda.

With the exception of the urine and rag-ley, the substances were applied on the 2d of April. It had rained two hours before they were begun to be applied, and continued to rain sometime after they were put on, which immediately washed the substances into the roots of the plants, and in the short period of four days the effects of the nitrate of soda, soot, and guano, were quite discernible. The rag-ley and urine were not applied until the last week of April, when the ground was very dry and the weather rather cold. An inspection of the crop was taken at intervals during its progress, but it will be sufficient to state that No. 9 took the lead in point of strength and dark green colour. About the end of May it was very superior to any of the others, both clover and rye-grass being very luxuriant. Nos. 3, 4, 6, and 8, were much improved at that period, but not equal to No. 9. No. 7 was in no respect improved. No. 2 a little. No. 1 growing luxuriantly. Previous to this the whole field had a good appearance, and nothing could exceed the luxuriance of Nos. 1, 4, 3, 8, and 9, but the drought at this time was becoming very severe, and the wind being from the east, the field was much exposed to it. In the middle of June, the whole field was suffering severely from the continued drought, but No. 9 was still keeping the lead, and, with the exception of Nos. 2 and 7, the rest of the dressed portions had a good appearance.

The hay was cut on the 13th and 14th of July, and when win each experiment was put into a rick in the field, where it stood until the 28th of August, when the whole was weighed at a public weighing-machine and stacked.

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* The water in which the rags are boiled at the papermills.

The following Table shews the Results.

No.	Description of Manures.	Quantity per Acre.	Cost per Cwt.	Cost per Acre.	Number of Imp. Stones of Hay.	Rate per Stone.	Value per Acre.	Value of Hay after deducting Cost of Application.	Gain per Acre.	Loss per Acre.
		gall's.	s.	s.		d.	L. s.	L. s.	L. s.	s.
1.	Urine, . . .	1920	–	32	240	6	6 0	4 8	0 16	–
2.	Rag-Ley, . .	1920	–	7	160	6	4 0	3 13	0 1	–
3.	Soot, . . .	bolls 20	–	20	216	6	5 8	4 8	0 16	–
4.	Saltpetre, . .	cwt. 1½	24	36	240	6	6 0	4 4	0 12	–
5.	Nothing, . .	–	–	–	144	6	3 12	–	–	–
6.	Nitrate and Sulphate of Soda,	1 / 2	19 / 9	37	216	6	5 8	3 11	–	1
7.	Common Salt, .	5	3	15	144	6	3 12	2 17	–	15
8.	African Guano,	4	10	40	228	6	5 14	3 14	0 2	–
9.	Nitrate of Soda,	2	19	38	268	6	6 14	4 16	1 4	–
		bolls.					L. s.			
3.	Soot, . . .	20	–	20	184	6	4 12	3 12	1 4	–
		cwt.								
4.	Saltpetre, . .	1½	24	36	192	6	4 16	3 0	0 12	–
5.	Nothing, . .	–	–	–	96	6	2 8	–	–	–
6.	Nitrate and Sulphate of Soda,	1 / 2	19 / 9	37	176	6	4 8	2 11	0 3	–
7.	Common Salt,	5	3	15	96	6	2 8	1 13	–	15
8.	African Guano,	4	10	40	176	6	4 8	2 8	–	–
9.	Nitrate of Soda,	2	19	38	208	6	5 4	3 6	0 18	–

The following is the Average of the two Experiments :—

No.	Description of Manures.	Quantity per Acre.	Cost per Cwt.	Cost per Acre.	Number of Imp. Stones of Hay.	Rate per Stone.	Value per Acre.	Value of Hay after deducting Cost of Application.	Gain per Acre.	Loss per Acre.
1.	Urine, . . .	galls. 1920	–	32	240	6	6 0	4 8	0 16	–
2.	Rag-Ley, . .	1920	–	7	160	6	4 0	3 13	0 1	–
3.	Soot, . . .	bolls. 20	–	20	200	6	5 0	4 0	1 0	–
4.	Saltpetre, . .	cwt. 1½	–	36	216	6	5 8	3 12	0 12	–
5.	Nothing, . .	–	–	–	120	6	3 0	–	–	–
6.	Nitrate and Sulphate of Soda,	3	–	37	196	6	4 18	3 1	0 1	–
7.	Common Salt, .	5	–	15	120	6	3 0	2 5	–	15
8.	African Guano,	4	–	40	202	6	5 1	3 1	0 1	–
9.	Nitrate of Soda,	2	–	38	238	6	5 19	4 1	1 1	–

All the substances employed, with the exception of common salt, gave at least a small profit; but I am inclined to think, had the drought been less severe in May and June, that the increase over the undressed portions would have been much greater. I may state, in regard to common salt, that although it has failed this season, 1844, I had previously used it to great advantage. In 1843 it increased the hay crop nearly one-third; and I presume that it was owing to the dryness of this season that it had no beneficial effect on the first crop, as the grasses appeared stunted in their growth after it was applied, from which they only partially

recovered; but, as the second crop was evidently benefited by it, and as the expense of applying it is trifling compared to some of the other substances, I think, in inland districts, or where the ground is not exposed to the action of prevailing sea-winds, it may generally be used to advantage.

The rag-ley gave only a small increase; but I am led to infer, from the above result, and from the appearance of the second crop, that, in localities where it can be obtained, it might be employed to advantage. In this experiment, the ground was exceedingly dry when it was put on, and did not get the advantage of a single shower till the crop was far advanced, which might prevent it from producing the effects it might otherwise have done; but when we bear in mind that a great quantity of it is daily running from the paper manufactories, without, as far as I know, being put to any useful purpose, I think it ought to be experimented upon, to see if it has any effect in promoting vegetation. I am not aware of the ingredients of which it is composed.

Being convinced of the great utility of applying urine as a top-dressing, I think it is always entitled to a place in experiments made for the purpose of testing different manures. In this experiment it was applied after the ground was very dry, yet it increased the crop ninety-six stones per acre, and the increase would probably have been much greater had there been more rain. Although the soot increased the crop nearly as much as any of the other manures, the hay was rather inferior in quality, as the clover did not succeed so well where it was applied.

Although the hay is all valued in the table at the same rate per stone, it may be proper to state that the quality of the hay was much improved on the portions dressed with nitrate of soda, guano, saltpetre, mixture of nitrate and sulphate of soda, and urine, which of course makes the gain from their application, considerably greater than what appears in the table.

The remainder of the hay crop on the farm was dressed with soot and urine, and the increase was much the same as in the above results.

The second crop was only allowed to grow about four weeks, until the cattle were put into the fields to pasture, so the value of it could not be so accurately ascertained; but, with the exception of the portion to which the soot was applied, all the others were decidedly superior to the undressed portion.

Potatoes.—The quantity of land experimented upon amounted to three acres—nearly level, with a northern exposure—the soil is earthy loam, superincumbent on clay, partially drained with stones, but not thoroughly dry. In the autumn of 1842, the field was ploughed out of lea, and sown with oats in 1843, which

was but a middling crop. After oats, it was ploughed deep in autumn, and cross ploughed and well cleaned in the spring of 1844. The drills were drawn thirty-four inches apart, and forty cubic yards of farm-yard dung were spread in the drills, the potatoes planted on the last day of April and first of May, and covered in with the double mould-board plough. The weather was very droughty at the time of planting, and the ground, of course, very dry, but the potatoes brairded regularly, and the dressings were applied during May and June, and the crop lifted and weighed on the 8th, 9th, and 10th of October.

The following Table shews the Results.

No.	Kinds of Manure, and when applied.	Quantity per Acre.	Cost per Cwt	Cost per Acre.	Quantity in Tons, &c. per Acre	Value per Acre.	Increase in Tons per Acre.	Value of Increase.
		Cwt	s d.	s d	tons cwt qrs	L s d	tons cwt qrs	L s d
1.	Guano applied on the 30th of April in the drill with the dung previous to planting the potatoes,	2	10 0	20 0	9 1 0	18 2 0	0 15 0	1 10 0
2	Rape-dust put in at the root of the stem about the middle of June,	5	6 3	31 3	10 1 1	20 2 6	1 15 1	3 10 6
3.	Guano applied on the top of the drill on the 30th of May, . .	2	10 0	20 0	14 5 1	28 10 6	5 19 1	11 18 6
4.	Nothing, . . .	--	--	--	8 6 0	16 12 0	--	--
5.	Guano put in at the root of the stem about the middle of June,	2	10 0	20 0	10 3 1	20 6 6	1 17 1	3 14 6
6.	Urine applied between the drills, as collected, during the months of May and June,	Gallons diluted 1920	--	32 0	11 11 3	23 3 6	3 5 3	6 11 6

It will be observed that, in No. 1, where the guano was applied in connexion with the dung, and in No. 5, where it was put on as a top-dressing *after* the plants had made their appearance, its effects were small in comparison to No 3, where it was applied on the top of the drill *before* the plants came up. Before applying it in this manner, the drills were well harrowed down with the common drill-harrow, and the guano carefully sown on the top of the drill, and then covered up with the plough, and rolled.

From the effects produced, I am inclined to infer that this is the most judicious method of applying guano to the potato crop. Throughout the season, this portion far exceeded any of the others both in point of strength and colour.*

Oats.—The field has a gentle declivity with a northern exposure. The soil, a sandy earth upon a subsoil of sandy clay. Not drained. The quantity of land experimented upon was five roods, and ploughed from clover lea in winter; sown on March 29th with Hopetoun oats, and the manures were applied the same day, and harrowed in with the seed. The ground was divided into oblong portions across the field of a rood each,† and these were the substances applied:—

1. Guano.
2. Common Salt.
3. Nothing.
4. Nitrate and Sulphate of Soda.
5. Saltpetre.

No.	Kinds of Manure.	Quantity per Acre.	Cost per Cwt.	Cost per Acre.	Produce of Grain per Acre.	Produce of Straw per Acre.	Quantity of light Grain.	Weight of Grain per Bushel	Rate per Quarter	Value per Quarter of light Grain	Value of the Grain Crop.	Value of Straw per Cwt.	Value of the Straw Crop.	Excess of Produce in Grain.		Excess of Produce in Straw.	Value of excess in Grain.	Value of excess in Straw.	Value of excess in Grain and Straw.	Gain from Application.	Loss from Application.
		cwt	s	s	q b p	cwt qr lb	bush	lb	s d	s	L s d	s	L s d	qr bu		cwt qrs lbs	L s d	L s d	L s d	s d	s d
1	Guano, . .	4	10	10	7 4 0	20 3 0	6	40	20 3	8	7 17 10½	2	2 19 6	1 8	2	11 0 0	1 17 6¼	1 2 0	2 19 6¼	10 2	
2	Salt, . . .	5	3	15	5 7 1	19 1 0	4	do.	do.	do.	6 3 7	do.	1 18 6	0 1¼	0	0 2 0	0 3 1¼	0 1 0	0 4 1¼	..	10 10¾
3	Nothing, . .	..	..	..	5 6 0	18 3 0	4	do.	do.	do.	6 0 5¼	do.	1 17 9¼								
4	Nitrate of Soda, Sulph. of Soda,	1 2	10 9	37	6 4 3	31 0 4	8	do.	do.	do.	7 1 6¼	do.	3 2 1	0 6¾	4	12 1 4	1 1 1	1 4 7	2 5 8	8 8	
5	Saltpetre, . .	1½	24	36	6 2 3	30 0 24	7	do.	do.	do.	6 10 4¾	do.	3 0 5	0 2¼	3	11 1 21	0 9 11½	1 2 11	1 12 10½	..	3 1

An inspection of the crop was taken at intervals throughout the season. On May 10th the portions to which the mixture of salt and saltpetre, and a little improved guano, were applied, was decidedly superior. On June 6th the guano

* An experiment was made with the ammoniacal liquor of the gas-works as a top-dressing both on hay and potatoes, and its effects were such as to encourage another trial, as both the portions were considerably improved, but as I could not depend on the accuracy of the results, I have not given them a place in the tables.

† It will be observed that these experiments were made on only one portion of land each. The farm not being of large extent, and a considerable portion of the hay and turnips being experimented upon with different manures last season, a sufficient quantity of land, and in the same state, could not be obtained to make the experiments two-fold.

portion was excellent, and the others still a shade better than the undressed portion. On July 1st the guano portion was again excellent, the salt giving no visible difference from the undressed portion, and both the mixture and saltpetre portions improving rapidly since the rains.

In these experiments the common salt and saltpetre failed to give an increase sufficient to defray the expense of application, and the mixture of nitrate and sulphate of soda gave but a small profit; but I would partly attribute this to the land having been in good condition, as the crop on the undressed portion was good, and the oats on the dressed portions were all lodged before they came to maturity.

The nitrates generally add more to the bulk of the straw than to the weight of the grain per bushel, and in this case, though the grain was winnowed to the same weight as that from the undressed portion, the quantity of light grain was greater. There was very little difference in the appearance of the samples after being dressed for the market, except that from the portion dressed with salt had the best colour.

Turnips.—The turnips occupied 13½ acres; the ground was nearly level; bounded on the north by a plantation, the other sides being exposed. The soil was a light gravelly earth, resting upon a gravelly subsoil. The field was ploughed out of lea in the autumn of 1842, and a crop of oats taken in 1843, which was a poor one, being only twenty-two bushels per acre. After the oats, the land was deep ploughed in autumn, and well cleaned in spring, previous to sowing the turnips.

Ten acres were manured with twelve cubic yards of farm-yard dung, one cwt. of guano, and eight bushels of bones per acre; these were sown between the 31st of May and the 10th of June. The crop averaged twenty-five tons per acre.

In order to ascertain the comparative effects of a few special manures, a portion of land of equal quality was reserved, upon which the following experiments were made. The drills were drawn at twenty-eight inches apart, and, in connexion with twelve cubic yards per acre of farm-yard dung, which were spread in the drills, the following substances were applied:—1*st*, A mixture of bone-dust and guano; 2*d*, guano; 3*d*, bone-dust. The experiments were made two-fold, on half an acre each, and a portion was left between the two sets of experiments with nothing but the dung, to prove their comparative effects. Immediately adjoining these, two single portions were manured with saltpetre and gypsum, and the results of the whole are given in the following tables.

The turnips were the Gordon yellow variety, sown on the 6th of June, and the crop was weighed on the 31st of October.

No.	Kinds of Manure.	Quantity per Acre.	Cost per Cwt.	Cost per Acre.	Produce in Tons, &c., per Acre.	Value at 10s per Ton.	Increase from Application	Value of Increase.	Gain from specific Manure.	Loss from specific Manure.
			s d	s d	tons cwt qr	L s d.	tons cwt qrs	L s d	L s d	L s
1.	Guano and Bone-dust,	cwt 1¼ bush 8	12 6 16 0	28 6	25 10 0	12 15 0	8 16 0	4 8 0	2 19 6	0 0
2.	Guano, .	cwt 2½	10 0	25 0	24 2 0	12 1 0	7 8 0	3 14 0	2 9 0	0 0
3.	Bone-dust,	bush 16	2 0	32 0	21 19 0	10 19 6	5 5 0	2 12 6	1 0 6	0 0
4.	Dung only,	c y 12	0 0	0 0	16 14 0	8 7 0	0 0 0	0 0 0	0 0 0	0 0
1.	Guano and Bone-dust,	cwt 1¼ bush 8	12 6 16 0	28 6	26 13 0	13 6 6	9 19 0	4 19 6	3 11 0	0 0
2.	Guano, .	cwt 2½	10 0	25 0	23 14 0	11 17 0	7 0 0	3 10 0	2 5 0	0 0
3.	Bone-dust,	bush 16	2 0	32 0	21 11 0	10 15 6	4 17 0	2 8 6	0 16 6	0 0
4	Saltpetre,	1¼	24 0	30 0	17 10 0	8 15 0	0 8 0	0 4 0	0 0 0	1 6
5.	Gypsum,	5	3 6	17 6	19 19 0	9 19 6	3 5 0	1 12 6	0 15 0	0 0
	The following is the average of the two Experiments:—									
1	Guano and Bone-dust,	--	--	28 6	26 1 14	13 0 9	9 7 2	4 13 9	3 5 3	0 0
2.	Guano, . .	--	--	25 0	23 18 0	11 19 0	7 4 0	3 12 0	2 7 0	0 0
3.	Bone-dust,	--	--	32 0	21 15 0	10 17 6	5 1 0	2 10 6	0 18 6	0 0
4.	Dung only,	--	--	0 0	16 14 0	8 7 0	0 0 0	0 0 0	0 0 0	0 0
5.	Saltpetre, .	--	--	30 0	17 10 0	8 15 0	0 8 0	0 4 0	0 0 0	1 6
6.	Gypsum, .	--	--	17 6	19 19 0	9 19 6	3 5 0	1 12 6	0 15 0	0 0

A few experiments were made on another part of the same field; and, although the portions of land were small, amounting to only one-twentieth of an acre each, yet the results are not uninteresting. The substances were applied in connexion with twelve cubic yards per acre of farm-yard dung, the turnips sown on the 28th of June, and the crop weighed on the 31st of October.

No.	Description of Manure.	Quantity per Acre.	Cost per Cwt.	Cost per Acre.	Weight per Acre.	Value per Acre at 10s. per Ton.
			s. d	L s d.	tons cwt qrs	L. s. d
1.	Bone-dust, . . .	bush 12	bush 2 0	1 4 0	14 0 3	7 0 4½
2.	Guano, ...	cwt 2	cwt 10 0	2 0 0	14 6 1	7 3 1¼
3.	Sulphate of Soda, .	3	9 0	1 7 0	11 17 2	5 18 9
4.	Dung only, . . .	--	--	--	8 2 0	4 1 0
5.	Rape-dust, . . .	5	6 3	1 11 3	12 19 1	6 9 7½
6.	Sulphate of Ammonia,	lb 100	lbs 0 4	1 13 4	8 2 0	4 1 0
7.	Saltpetre, . . .	125	cwt 24 0	1 6 9½	9 19 3	4 19 10½

In these last experiments the land is nearly of the same quality with the portions upon which the other experiments were made, but the crop was much inferior throughout, which may partly be ascribed to the farm-yard dung being inferior and partly to the season having been too far advanced when the turnips were sown, all the late sown turnips in this district being deficient this season, 1844.

From these results, and the experience of former years, I am led to conclude that, when guano and bone-dust can be obtained at a moderate price, they may, in all cases, be applied with the farm-yard dung to turnips with advantage. In these experiments the crop was greater when these two substances were applied together than when applied separately, and, when we consider the nature of bone-dust and guano, it is evident that a mixture of the two will always have a good effect; for where guano is applied alone it causes a rapid growth, and the turnips have a tendency to ripen prematurely, while, on the other hand, the bone-dust causes them to come away slowly, but continues to grow them till the season is far advanced. Now, when both are conjoined, the guano secures a regular braird while the bones keep the turnips in a growing state during autumn. In the above experiments the turnips with guano kept the lead till about the middle of September, when they began to fade a little in the tops, and where the mixture was applied they continued so luxuriantly for a month afterwards, but, when weighed, were beginning to fade, while the bones kept them still green and improving daily. Seeing this to be the result when applied in connexion with farm-yard dung, the inducement to apply them conjointly is considerably greater when no farm-yard dung is allowed. I have not unfrequently seen turnips with bones comparatively useless from being tardy in brairding, and I have likewise seen them with guano very deficient on account of ripening prematurely, but I have always found them excellent when these two substances were applied together.

The turnips on the gypsum portion brairded rather irregularly, but improved much during September and October. Those on the saltpetre portion likewise brairded rather irregularly, and failed to increase the crop so much as to defray the expense of the application. The sulphate of soda, though not equal to bone-dust and guano, appeared throughout the season to have a considerable effect. The rape-dust portion had always a healthy appearance. The sulphate of ammonia seemed to have very little effect.

Having been in the habit, for a number of years, of making experiments with different manures, I have not been inattentive

to the effects which they produce on the succeeding crops of the rotation.

In applying bone-dust to turnips, I have frequently found that, at the rate of from twenty-five to thirty bushels per acre, the crop was as good as when thirty cubic yards of farm-yard dung were applied, but the succeeding crops in the rotation, particularly the hay, were generally deficient; but, by consuming the half of the turnips on the ground by sheep, the crops throughout the rotation, were as good, and often superior to those manured with farm-yard dung.

Nitrate and sulphate of soda have an excellent effect when applied as a top-dressing to the potato crop; but I never could discern any difference on the succeeding crops. Soot, when used as a top-dressing on hay, seems to exert the most of its influence on the crop to which it is applied. Guano appears to benefit every kind of crop without exception, and although it is of an active nature, and brings the crops early to maturity, its effects are not confined to the first year. Last year, 1843, I used it to a considerable extent as a manure to the hay, turnips, and potatoes. Where it was applied to the hay there was no remarkable difference in the oats of this season; but its effects in the second year could not be expected to be great, as it was used only at the rate of one and a-half and two cwt. per acre; but where it was used in the drill at four cwt. per acre for potatoes, the oats were superior this season to those manured with farm-yard dung at the rate of thirty cubic yards per acre.

A field, which is rather steep, and to which it is difficult to apply farm-yard dung, was manured with bone-dust in 1839 for turnips, the whole of which were carted off the field, and only a small allowance of lime compost applied the following spring. The crops were good throughout the rotation, and it was again manured for turnips in 1843 with guano at four cwt. per acre, which raised a good crop, the half of which was consumed on the ground by sheep. The oats which followed were excellent, and the seedling grasses on the field at present are beautiful; thus shewing that the land may be kept in a high state of fertility without the use of farm-yard dung. But I would consider it the most judicious practice to apply either guano or bone-dust as an auxiliary to farm-yard dung rather than as a substitute.

In situations where the dung made on the farm is all the putrescent manure that can be obtained, it is, no doubt, a great advantage to the cultivator to obtain these fertilizing ingredients at a moderate cost, as, by applying the dung made on the farm in connexion with these substances, to the whole turnips and potatoes, almost any farm may be brought into a high state of fertility.

THEORY OF MANURES—THEIR AGENCY AS FERTILIZERS.

Communicated by JOHN TOWERS, Esq., Pinkney's Green, near Maidenhead.

THIS subject may be trite; for so much has been written, that many may conclude that little or nothing to the purpose remains to be advanced. Perhaps, however, it will not be difficult to shew that, as yet, we have attained to nothing like a sound and philosophic principle of manuring; and that received opinions—if such, indeed, exist at all—are founded upon loose conjecture. The very introduction, not only of foreign *guanos*, but of some score of what are called artificial manures, with the whole range of comparative experiments which are weekly announced in the agricultural press, tend to prove that such, indeed, is the fact.

I have been considerably impressed by the perusal of the article on the Over-liming of Land, at p. 480 of the *Transactions of the Highland and Agricultural Society*, for March 1845, as it proves that error can pass current without the slightest inquiry, from father to son, for any indefinite period. In that able article it was proved that a light and open state of certain soils, particularly in certain districts, which was ascribed to the *superabundance of lime*, could in no degree be referred to liming, inasmuch as, in five specimens of soils conjectured to have been overlimed, analysis distinctly proved that the quantity of carbonate of lime did not amount to *one and a-half per cent.!* And the writer adds (what I myself can go far to confirm) that "in some *fertile* soils, which are capable of growing luxuriant crops of wheat, the quantity of carbonate of lime amounts to as much as *forty per cent.*"

It is not now my object to discuss the subject of liming. I only adduce this fact to evince the predominance of vulgar error, and to confirm what has been above stated, that we as yet have not attained to a sound general principle of manuring.

By the term *manure* I mean to express all putrescent fermentable substances, such as farm-yard dung, fold manure, and the contents of drains and sewers, that may for several reasons be called *cloacine;* also guano, and decaying vegetable matters: in a word, everything that is resolvable into the organic elements, oxygen, hydrogen, nitrogen, and carbon—rejecting for the present all artificial or even bone manures, the bases of which are *in*-organic.

At or about the period when the theory of *Humus* was first broached, and became accredited, I was induced to devote considerable attention to it, and then addressed several articles to periodicals, which appeared in due course. To one of those, in

particular, which was printed in the *Gardener's Gazette*, I solicit attention, in as far as it will prove that a view was then taken of the *humic hypothesis* in advance of the agricultural opinions of the day, but which is found at this period to correspond with the more recent discoveries of science.

It will be admitted that in the years 1837 and 1838 guano and the now advertised manures were scarcely known; that professors and lecturers upon agricultural chemistry had made no advances. What, therefore, I wrote in 1838 must have been original, so far, at least, that it could not have been borrowed from anything that has been since promulgated. I thus expressed myself:—

It has generally been supposed that manures constitute the food of plants, and that they become so by being *dissolved* in the moisture of the soil, which solution is taken up by the absorbent vessels of the roots of plants, whence, under the form of sap, it is distributed throughout the vegetable structure.

The doctrine is plausible, but, like that of the laboration of the tree sap in the leaves, and its descent to the inner bark, it is involved in doubt and uncertainty. It is, indeed, extremely difficult to conjecture what part manures *can* perform in the functions of vegetable nutrition; because it is quite certain that *not a single particle of the most impalpable powder can be made to enter into the vessels of the roots;* and it is equally certain that water—boiling water—can dissolve only a very small portion comparatively of the most reduced spit-dung. But every observant gardener or farmer must have remarked that, when manures are added to earths in due proportion, and not so as to glut the soil, the whole mass vanishes; and though, for a time, the earth be somewhat blackened, it gradually acquires its natural tint, and loses every trace of the decomposable substances which were added to it.

Another fact is apparent, namely, that under the stimulus of a vegetable crop, land frees itself from the manure sooner than if it were left to act solely by its own unassisted energy.

It is not long since the public was amused with a novelty; for the cold black mass of the dunghill was dignified with the title of *humine*, whence also we obtained another chemical compound called *humic acid*, which last was declared to be a combination of oxygen with humine, in a state of preparation easily *soluble* in the fluids of the soil, and to be thus the real and prepared (or "cooked") food of plants, fitted to be taken up by their radical absorbent vessels. This assumption, the very dandyism of science, was at the time sufficiently exposed, and we now hear little more of humus or its relatives. But the doctrine of the *dissolution of manures* is still credited, and, therefore, it behoves every one who perceives its fallacy to expose the delusion.

Manures, we have said, are but scantily soluble in water; but they are found to vanish, and in time to be entirely consumed. To become, therefore, the food of plants, they must be decomposed, (not simply dissolved,) and thus be resolved into their elements. The analysis of black spit-dung by distillation, or the application of fire, clearly proves what these elements are. A considerable volume of gaseous fluid is obtained, consisting of carbonic acid and hydro-carbons. Some ammonia may often be traced; and these gases prove the existence of bases which, upon the application of fire, have yielded oxygen and hydrogen to form water, oxygen and carbon to form carbonic acid, and hydrogen and azote to form ammonia. But besides aeriform fluids there are solid matters which remain in the vessels exposed to the direct fire, and these are, generally, free charcoal, alumina, chalk, oxide of iron, and one or more neutral salts, in varying proportions.

Now this decomposition, or one more slow in its progress, but closely resembling it in character, is carried on in the soil; and the only agent of the combustion that we can by possibility trace, is water. Of this mysterious agency the wonderful discoveries of Mr. Faraday became the best interpreters. Thus, *a single grain of water* was found to contain a volume of electricity equal to that of a powerful flash of

lightning, and that, to decompose such a minute drop, it required a stream of voltaic electricity of intensity sufficient to keep a platina wire red-hot during a considerable period.

A power capable to decompose water would, therefore, be an all-sufficient cause of the decomposition of manures deposited in the soil, and of the new arrangement of their elements into nutritive sap, and other products which perform vast and important offices in the economy of nature.

There are crudities in the foregoing article which the luminous writings of Liebig and other great analysers enable us to correct; and, now, therefore, I venture to offer my new theory of manure, founded upon the induction of those great facts which philosophy has recently elicited. Since the introduction of foreign guano a great variety of artificial compounds have been produced, all tending to one leading point, namely, that, so far as the ground is concerned, the bulk of manure may be reduced to a very small compass, and that *inorganic* substances perform a much more important role than was formerly contemplated. In this view of the operation of manures, I think that modern experiments have gone far beyond the hypothesis of the great German chemist, Liebig; for he insisted upon the importance of humus (or semi-reduced vegetable matter) as a generator of *carbonic acid*. But in order to avoid prolixity, I shall desist from any reference to the new manures, and confine my remarks to that old and approved fertilizer, the *manure-heap* of the farm and fold-yard, and, assuming this as the most approved and comprehensive type, I propose, by an analytical arrangement of its chief constituents, to aim at an elucidation of the philosophic principles of manuring.

Farm-yard and fold manure consists of semi-reduced straw, hay, and the fœcal excretions of live stock. The two former abound with siliceous or flinty matter, an *inorganic* substance evidently obtained from the ground; the *organic* elements, all of which are capable of being developed in the form of aerial gases, are *oxygen*, *hydrogen*, (the bases of water,) and *carbon*, the base of carbonic aerial acid. The animal matters contain also the same organic elements, with the addition of nitrogen, which latter, combining with some of the hydrogen, forms and passes off in the state of ammoniacal gas, whence the pungent odour which is so perceptible in stables and dung-heaps, when in their first heated state of active fermentation. Besides these organic elements, the fœces of animals comprise some inorganic salts and phosphates not resolvable into gaseous fluids.

I do not intend to enter into anything like a minute chemical analysis of manures—that has been done by numerous writers, and the results are detailed in all the scientific agricultural periodicals of the day. I merely propose to shew, generally, what are the gasefiable constituents of farm-yard manure, including

cloacinæ, (that is to say, the ordure from house-drains, &c.,) and what those inorganic salts, and more solid matters which remain after the completion of the multifarious decompositions effected during the processes of fermentation.

In the first place, if a mass of mixed manures be kept till it be brought to the condition of black spit-dung, little more remains than a very reduced quantity of carbonaceous vegetable matter, blended with the silex of the straw, and some trace of metallic oxides: it is the product of slow combustion, termed by Liebig *eremacausis*, and, with the exception of old decayed wood, is perhaps the best representative of *humus* which we possess. The public were amused, or rather mystified, about seven or eight years ago, with the introduction of the fanciful terms *humine*, *humus*, and *humic acid*, all of which had their origin in the Latin word *humus*, the ground or earth, and, therefore, conveying no definite intelligible meaning, unless it be that of a certain substance which confers a nutritive quality on the native earths. The humic theory was, however, effectively assailed about the period alluded to, and to render it finally innocuous, it only remains necessary to insist upon the great and unquestionable fact, that no particle of *humus* can, by possibility, be taken up by the roots of plants; that even the *colouring* matter of liquid draining from the dunghill is equally excluded from sound and growing roots, though it *can* pass through wounded portions of both roots and stems; and, therefore, that *humus*, solid or liquid, cannot be, in its direct action, the "prepared" or "cooked food" of vegetables. While insisting, however, upon this paramount principle, we must admit that reduced manure is indispensable to fertility, inasmuch as it becomes a fruitful source of *carbonic acid*, and moisture being in itself convertible into those products, under the action of the roots of plants, or rather of their *vital principle*, by which much of the remaining carbon is generated, and the small residue deposited in the form of black charcoal.

We can now perceive how a large mass of manure is disposed of. In a word, almost every tangible portion is developed in the forms of watery fluid and invisible gases, leaving only an almost inappreciable proportion of carbon to be added to the bulk of the soil, unless we except the inorganic salts and siliceous matter reduced to a state of extremely minute division.

The charcoal finally deposited, cannot, however, be taken up by the roots of plants; and thus every, the most minute, solid particle of manure, though its weight amount to tons when ploughed into the land, must undergo a total change, through the agency of powerful chemical affinities, before it can supply sap to the absorbent organs of the roots.

It only remains to offer a few remarks upon the agency by which a bulk of manure is so changed as to be reduced to a mere modicum of solid matter, which likewise, (if we except the few inorganic residua,) is of no other avail than as an absorbent of moisture and other products of fermentation.

From the previous statements, it will, I hope, appear that every particle of putrescent manure which is given to the earth must undergo a decomposition which can only be induced by the play of chemical affinities, and those so powerful as to develope the elements of water, to re-form water; also the elements of hydro-carbons and of ammonia; and to model and incorporate all these so as to produce that specific crude sap which is exactly appropriate to each individual vegetable.

Chemical agencies involve electric induction, and water can only be electrically decomposed, as Faraday has shewn, by the passing of a current. Now in the germination of seeds water is decomposed and heat is generated; during the protrusion and advance of roots also, the manure is decomposed, and new modifications of its elements effected. But to what primo motor cause are we to look, as that which gives the first spark, or rather what the *medium* through which that elemental stream passes, which induces those mysterious decompositions and recombinations?

The theory of electro-culture excites much interest at the present moment, and the inquiries thus set afloat cannot fail to elicit important facts; still, as we already know that a handful of green grass, a blade of corn, and vegetable-pointed terminations of every description, rank as the *best* of all electric conductors, as likewise we are sure that the air, and every particle of matter, are replete with etherial fluid, of which the sun is beyond doubt the fountain, it seems more than probable that each vegetable body, even at its first emergence from the soil, *receives* from light and air, and *conveys* through its organization, that *electricity* which connects heaven with earth, decomposes terrestrial moisture, and thus produces the current that effects, in specific and harmonious order, all other required electro-chemical changes.

Admitting that the voltaic apparatus furnishes the type of the current, and knowing the electric condition of the atmosphere, what other agent need be sought? Manures *are* decomposed most rapidly under the action of a vegetable crop, and atmospheric electricity rushes through every pointed termination of the structure; we cannot, therefore, doubt the superior efficacy of introducing a *bulk* of manures like those of the farm-yard and fold, over the mere top-dressings and scatterings of guano or its

representatives, as by the former it enjoys all the *direct* results of organic developements, and obtains a permanent fund of carbonaceous substances, whence to derive an ample supply of carbonic acid, whereas the latter may be considered as the *remains of laborations already effected*, and, therefore, deficient in one of the chief requisites of vegetable nutrition.*

SUPPLEMENTARY NOTICE ON THE SUBSTITUTION OF TUBES MADE OF LARCH WOOD FOR DRAIN-TILES USED IN DRAINING.

By William Scot, Esq., of Craigmuie, Stewartry of Kirkcudbright.

The attention of the agriculturist to the importance of thorough draining with tile has now been so fully roused, and the system is in such active operation, especially throughout the more valuable and productive districts of Scotland, that time alone seems to be all that is required for the completion of that essential improvement. There are, however, other, and, unfortunately, very extensive districts in Scotland, in which physical obstacles present themselves to that mode of drainage, either from the impossibility of procuring tiles at a moderate expense, or from the nature of the soil not being adapted to the use of tiles, or from the combination of these two causes.

It is now several years since I ventured to bring before the public notice a plan for obviating such physical obstacles, by the substitution of tubes made of larch wood for the common drain-tiles made of clay; and I then endeavoured to shew that in many situations this proposed substitute formed not only a most efficient kind of drain, superior in some respects even to tiles, but was also more economical.

In the paper to which I refer, published in the *Transactions of the Highland and Agricultural Society* for September 1841, p. 99, I expressly limited my proposal "to those localities where larch wood was cheap and abundant, and where tiles were not readily procurable at a cheap rate;" and I gave some calculations of the relative cost of wood and tiles applicable to such localities. Being sensible, however, that some degree of mistrust is very naturally entertained respecting calculations of value not founded on abso-

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* These thoughts of Mr Towers may, perhaps, have the effect of directing the attention of some agriculturists to the premium on *electro-culture*, placed at the disposal of the Society by Mr Gordon of Knockespock. The grounds upon which this premium has been offered will be found explained at p. 508 of the Society's Transactions for March 1845.—Ed.

lute buying and selling, I do not regret that the drought of the two last seasons, by putting a temporary stop to the operations of the saw-mill, has given me an opportunity of testing these calculations by the actual purchase both of wood and tiles; and I conceive that it may not be uninteresting to the Society to hear the result. I stated in my former report that, taking larch wood of the quality usually employed for making paling and sheep-bars, and at the ordinary selling price in my neighbourhood in Kirkcudbright, the quantity required for one rood of eighteen feet of drain tube, four inches square, and including sawing, would cost 6d.; but on offering that price at a saw-mill in the vicinity, it was stated that, owing to their wood being of a superior quality, which it certainly was, they could not afford to sell it for less than 7d. per rood, and I accordingly purchased it at that rate. The wood was delivered ready sawn into the requisite lengths of six feet, the requisite breadths of four inches for tops and soles, of two inches for the side pieces, and one inch in thickness throughout: in short, ready in all respects to be bored and pinned, which operation, on repeated trials, very carefully conducted, did not exceed 1½d. per rood; but call it 2d., and we have the tubes finished at 9d. the rood, including every expense. I do not include the carriage from the mill, because, in all my calculations, I proceeded on the principle that a proprietor was to operate with his own wood and his own mill. On the other hand, purchasing tiles at the nearest kilns, viz. at Dumfries and Dalbeattie, each distant about twenty miles, the cost was as follows:—

1000 drain tiles of three inch, ...	L.1	10	0
Cartage, each cart carrying 233 tiles, at 6s. . . .	0	18	0
2,000 dressed slates for soles, at 7s. per 1000, . .	0	14	0
Cartage of ditto, ...	0	8	0
	L.3	10	0

The tiles were only twelve inches in length, and the slates six inches square, and the quantity specified above served to lay fifty-five and a-half roods of eighteen feet, thus costing 1s. 3$\frac{1}{7}$d. per rood, or very nearly 1s. 3¼d., thus leaving a balance in favour of wood of 4¼d. per rood; and, had the wood been my own, the balance would have been a penny more. I preferred purchasing dressed slates to refuse slates, at the cost only of the carriage, because the time and labour expended in chipping and laying the latter, counterbalanced much of their cheapness; and, after all, they make but an indifferent floor. The dressed slates, even, are not equal to tile for soles, on account of their shortness, but they are more portable. In my former report, I calculated that the cost of drain-tiles, at the prices of 1840 and 1841, would amount to 1s. 2½d. per rood, with the kiln at the distance of a few miles,

and taking the average length of tops and soles at $13\frac{1}{2}$ inches. Since then, however, the prices have been reduced.

Professor Low, in his late work on "Landed Property," calculates the cost at $8\frac{1}{4}$d. per rood, the kiln being only one mile from the farm—a single-horse cart carrying, on a medium, 450 tiles and 900 soles—which might perhaps be done for so short a distance, and the length of tile fifteen inches, which I apprehend to be above the average length in most parts of the country. At the same rates, tiles of twelve inches would be $10\frac{1}{4}$d. per rood. It would thus appear that, in all those inland and Highland districts where "wood is cheap and abundant," in which alone I advocate its use, it will be the more economical material, even were there a tile-kiln on the spot.

I cannot but feel gratified at having thus had an opportunity of verifying, by actual experience, the correctness of my former calculations, which, indeed, has become of particular importance, since, in two recent and highly valuable publications, Professor Low on "Landed Property" and Mr Stephens' "Book of the Farm," the invention of larch-wood tubes for drains has scarcely received a fair measure of justice.

Professor Low states as follows:—

"Boxes of wood have been proposed for drains. These are made of the smaller wood of fir plantations, and are formed into oblong boxes, the sides of which are loosely put together by wooden pegs, and perforated so as to admit the water. These boxes may be found useful in cases of soft peat, but they are more expensive than tiles, and thus are less suited for general use."

Now I submit that this is hardly a correct description. The tubes are not made of *fir*, at least in the popular sense of that term, by which most people would understand *Scots fir*, a very perishable material; but of larch, and of a tolerable size, a wood peculiarly adapted for long duration in its position under ground. Neither are they loosely put together, but, on the contrary, so firmly that they will stand very rough usage, infinitely more so than tiles. But what I chiefly complain of is the manner in which their use is contrasted with that of tiles, and set aside generally on the ground of their greater expense. If reference be made to my paper, page 99 of the *Transactions* for 1841, it will be seen that I specially deprecate such contrast. The very title of the article itself expresses this—"On the substitution of tubes, made of larch wood, for drain-tiles, in situations where the former is cheap and abundant, and the latter expensive, or not easily procurable." It is quite true that larch tubes are not suited for *general* use; they were never proposed for it: but I think it would have been but fair, in stating this acknowledged fact, to have likewise stated the circumstances under which their

use *was* indicated, not only from their cheapness, but from their superior adaptation to the soil of those very localities which present such circumstances.

Mr Stephens, again, calculates the comparative cost of tiles and wooden tubes in this manner.

"Take the cost of tiles at 30s. per 1000, including carriage, that will be 1½ farthing per lineal foot." But here he omits the cost of the sole,* although in his previous argument he makes out, in the most convincing manner, that the use of the sole is indispensable; at any rate, in comparing the expense of tiles with wood, the tubes being complete with soles, it is but fair to take soles into account. Adding one half, therefore, as the cost of sole tiles, they will come to rather more than 10d. per rood, or 2¼ farthings per foot. Mr Stephens does not give the estimate by the rood. He then calculates the cost of wood thus:—"A lineal foot of larch contains, say 1 superficial foot of timber, 1 inch thick, costing for carriage and sawing 1 farthing. The fitting, boring, and pins will cost 2 farthings, and the timber, at 6d. the cubic foot, costs 2 farthings more, which altogether makes the tube more than three times dearer than the tile; and if the cost of the timber be thrown into the bargain, still they will be double the price of tiles." This very formidable array of farthings, amounting to 5 per the lineal foot, against 1½ for tiles, appears sufficiently discouraging; and, were it correct, it would certainly be the prudent plan to consign wood to the flames. Mr Stephens' calculations may be correct according to the circumstances in which they were made. These I do not know.† But what I do know is this, that where I am situated I can make up the tubes at 8d. the rood, with my own timber, *including its marketable price;* at 9d. the rood with bought timber, or 2 farthings per lineal foot; and that if Mr Stephens will kindly afford me the opportunity, I will engage to teach him, in one day, to bore and pin the tubes with his own hand at the rate I have mentioned. I am the more concerned that this (as I consider it) erroneous statement should have been made, as in other

* When this paper was read at the Society's monthly meetings in the Museum, Mr Stephens stated that 30s. *included* the cost of the soles. His calculation must therefore stand, as stated in his work, in all situations where tiles can be procured at so cheap a rate.

† The circumstances, we believe, in which Mr Stephens made his calculations were simply these:—That as tiles and soles of 15 inches in length can generally be procured in the country for 30s. per 1000, the cost of draining, in as far as they are concerned, is from 5d. to 5¼d. per rood of 18 feet. If drain-pipes of 15 inches in length be employed, their cost being only 15s. per 1000, the expense of draining will be reduced to about 2½d. or 2¾d. per rood of 18 feet. In both cases the cost of clay tiles is much below that of larch tubes. Mr Stephens, we also believe, adopted the lineal foot as the measure of his calculations, because while the *rood* varies so much in length in different parts of the country, the foot is the same everywhere.—Ed.

respects I cannot but be gratified at the very favourable notice he has taken of the larch-tube method of draining.

While on this subject, I may state that pins made of larch are now found to answer as well as any other kind of wood. They are entirely cut and cross cut by the circular saw, and with the greatest ease and rapidity. They need no dressing or pointing whatever, but are readily driven, square, into the round augre hole, making what workmen consider a very firm job. Then, with regard to boring both the water and pin holes, we can, by a simple and unexpensive adaptation of racks and pinions, work the whole five augres for a six feet tube, simultaneously piercing two or even three boards at a time, and thus reducing the cost of this part of the process by nearly four-fifths. My estimate, however, is made on the old plan of working *one* augre. Whether the nature of the land, which alone I represent as being favourably circumstanced for the use of the wooden drains, will indeed repay the expense of thorough draining, is another question, and one which I do not pretend to decide. But I will at least venture to affirm this much, that it may be *partially* applied with great advantage, both as to profit and appearance, in redeeming many fine parks and enclosures in upland countries, which are marred and defaced, and rendered hurtful to stock, from the effects of springs welling out, and forming large patches or fringes of deep boggy ground, covered with rushes, spritt, and rank grasses, or forming extensive black mossy sloughs, sometimes of great depth, and which neither tiles nor stones are calculated to drain. Tiles cannot be kept in position in such soft places, nor can stones. They sink down, and are sludged up, unless indeed they be supported on long wooden laths. Even if the drains could be cut to the depth of the hard bottom, which cannot always be done, the moss, in a semifluid state, flows in from the sides of the cut, and chokes up stone drains. It is in such situations that the tubes are preferable to any other material, as by having them six, or if you choose twelve feet in length, and placing a cross-bar beneath their junctions where the moss is soft and deep, they will always preserve their level, and form a continuous and free passage for the water.

In this manner, without any considerable expense or trouble, and without involving the general question of a thorough drainage of unproductive land, proprietors have it in their power to add greatly to the value as well as to the beauty of their property, by such partial application of wood draining; and I am satisfied, for the reasons stated in my former paper, that this method of disposing of their timber will yield a better return than the prices usually obtained for it in the shape of paling or sheep bars in most of the inland and upland districts of Scotland.

THE WINTER AND SUMMER KEEPING OF FARM-HORSES.

By Mr James Carmichael, Raploch Farm, near Stirling.

[Premium, Ten Sovereigns.]

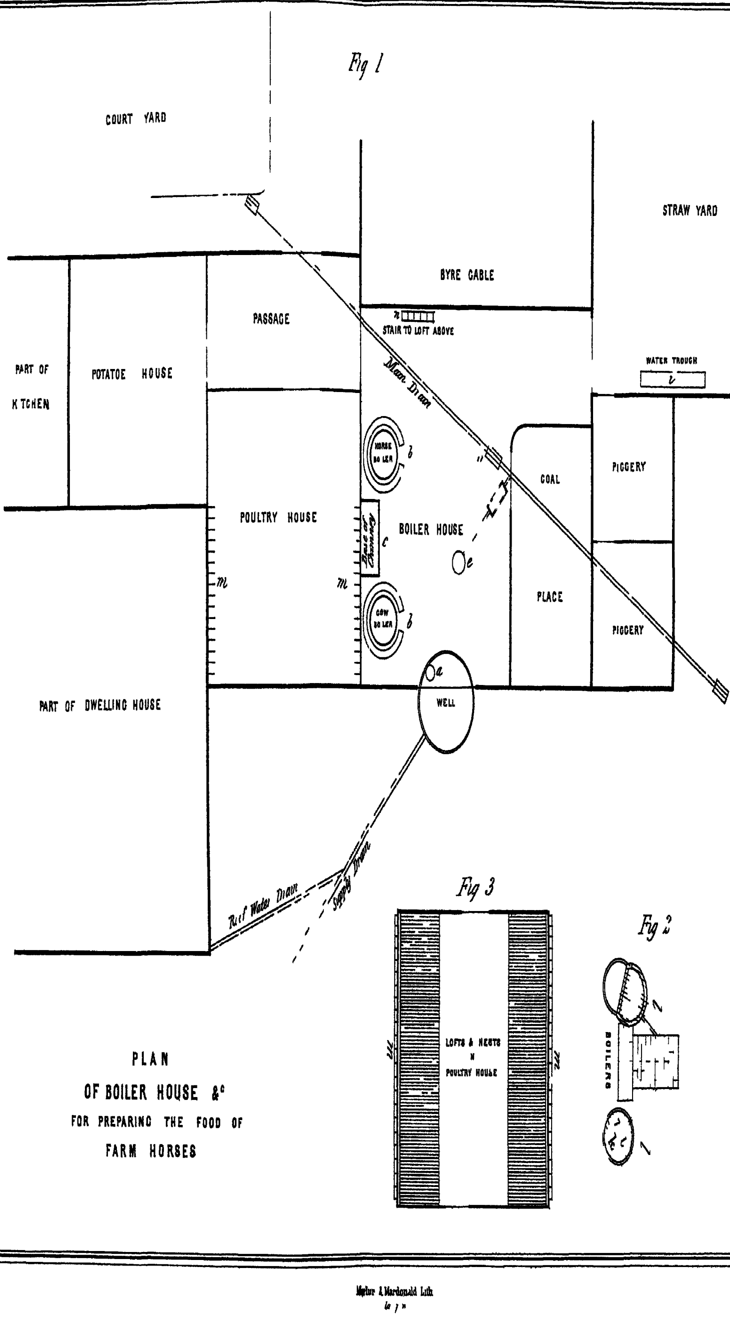
The management of live stock of every description certainly never was better understood, nor more generally attended to by the agriculturists of any age or country, than by the British farmers of the present day. Nor can there be any stronger proof of the justness of this remark than is everywhere exhibited in the high degree of perfection to which every species of live stock have now been brought with reference to all the physical properties of strength, symmetry, and size, necessary to develope the natural usefulness and utmost value of the various animals composing the stock of every farm.

But seeing that some of these animals are wisely designed for human food, whilst others are doomed to perpetual labour only, there is reason to fear that present gain may at times prompt individuals to pamper the ox and pinch the horse more than sound discretion or the real interest of the parties would justify. Not that any one, farmer or no farmer, is so inconsiderate towards such faithful servants and disinterested labourers as to deprive his horses of the necessary supplies of food, whilst he, at the same-time, requires their daily aid in the varied operations of the farm, yet the effect may be very much the same upon the health and physical condition of the horse, whether his food be limited in amount, or be deficient in quality, or improperly administered.

Nor can the inconsistency be denied of the complaint general amongst agriculturists of the great expense of keeping their horses, whereas not one word is uttered against the sums annually laid out for artificial food in preparing their cattle for the shambles, strangely forgetting that as surely as the one animal repays (which, by the way, is not always the case) all this expense, so also does the other, even with compound interest, though undoubtedly in a very different form.

How unphilosophical and unjust, then, to grudge that noblest of quadrupeds, the horse, the full amount of nutritious provender which the physical structure and the constancy of his laborious toils absolutely require, and without which farming would indeed be a difficult and gainless undertaking.

But as economy is at all times highly commendable, and now become absolutely necessary in every department of life, the main point of inquiry here is, *How farm-horses may be kept in the best working condition during summer and winter*; that is, what are



PLAN
OF BOILER HOUSE &c
FOR PREPARING THE FOOD OF
FARM HORSES

Maclure & Macdonald Lith

the quantities and qualities of provender best adapted, without want or waste, to the proper maintenance of work-horses in fair condition for their work at all seasons.

It must, however, be obvious that this proposition admits of an almost endless variety of answers, seeing that every district has its peculiarity of work and produce, and, therefore, the forage of agricultural horses must be confined to the crops of the farm, so far as these comprise the ordinary produce of straw, hay, and oats, with cut or uncut green food. In the *heavy-land* districts, where *beans*, *red clover*, and *turnips*, enter into the rotation of crops, the mode of keeping horses is very simple and satisfactory in every respect. It is this:—From the month of June, or whenever the clover, intermixed with rye-grass, is sufficiently advanced in growth to admit of being cut, which is generally determined by the blooming of the rye-grass and formation of blossom-buds on the clover, the horses gladly return to this succulent food from the dry straw or best hay, and will soon become plump and sleek on it without a single feed of oats, except on occasions of an extra day's work, throughout the summer, the first cutting serving till August, when they are supplied with cut tares for a week or two, and thereafter kept upon the second crop or *aftermath* of clover till near the end of October or so, and are then placed on their former fodder of bean-straw, which is continued till next return of cutting grass.

In the winter months, however, each horse has a daily mess or mash of boiled or stewed (not steamed) bean-chaff, mixed with light corn and small beans, separated by the winnowing-machine or sieve from the best grain, to which a few turnips and a portion of salt are added, with just enough of water to secure the boiler from injury, whilst the whole is being reduced to a pulpy state, and the pulp is then put into one or more troughs, to remain till the evening, when the mash is divided among the horses, at a temperature of about blood-heat, immediately on their return from the yoke.

Nothing can be more grateful to poor jaded horses, coming in cold with rain, though warm with perspiration, than this repast, and the avidity with which they partake of it, after being rubbed down, is the best proof of its congeniality to their tastes. In fact, they are quite impatient until its arrival, far more so than in the case of an expected feed of oats, and will hardly taste the straw, however hungry, before they have finished their mash, when they become quiet, and pick at the racks, or soon lie down, if much fatigued; thus shewing that even the commonest offals of the barn-floor, may, when combined with one or two other equally simple ingredients, be formed into substantial and really nutritious food for the hardest-working farm-horses, with

the additional allowance of one feed of inferior oats and beans in the morning, and another at mid-day, when constantly employed.

In this manner are all the farm-horses of the principal clay-land districts of Scotland maintained in the very best possible condition, without a particle of any other forage, from season to season, care being taken to arrange the supplies so as to leave one or two old bean-stacks remaining to commence the winter season with, because of the flatulent nature of new bean-straw before it has been some time in the stack, or otherwise deprived of its superfluous moisture.

The same plan is adopted in several other corn-land districts, where few or no beans are cultivated, by substituting pea-chaff for that of beans, or, in absence of both, putting oat-chaff, chopped straw, or hay, or the like, into the boiler, along with the small barley, or oats, turnips, and salt, and even buying beans for the express purpose of being thus used for the horses, long experience having shewn that no other form of feeding, nor any other mode of supplying the horse with beans, can equal that of boiling them, when the object is chiefly to keep his bowels right and his body lusty. Boiled beans, interchanged with dry corn, are, therefore, invariably preferred by horse-dealers when at hand, as the readiest method of *making up a horse*, as it is termed, for the market, in at once giving him more flesh and a finer coat.

Beans and pease are, from their wholesome, as well as on account of their nutritious, properties, thus largely used alone or mixed, bruised or whole, with oats, for horses at all the public works, and also by carriers, carters, and cowfeeders, who find bean-meal very fattening, besides being productive of more and better milk than any other grain similarly used; and a mixture of dry beans and oats in any form is, therefore, generally considered much better for horses than oats alone, which, long continued, with other hard food, always heat the system, and thus the animals become rough or *staring* in their coat, however well groomed. Indeed the difference between the two modes of keeping is so perceptible, especially in heavy draught horses, that their very appearance will in almost any circumstances determine the question of their manner of feeding.

It will, perhaps, be objected by some that this dietary must have a tendency to render the horses *soft*, or more easily heated while under its influence; yet those who have longest practised it (twenty to thirty years) cannot discover any other difference in this respect than what is well known to occur in the case of all lusty horses compared to lean ones, placed side by side in the same team, and both fed on some other quality of food. The highest conditioned, *i. e.* the fattest horse, assuredly will always be the first to perspire, when both fat and lean are placed on

precisely the same footing in every other particular save their food, except when the lean horse is overcome by the draught, or fatigued, which he certainly will soonest be, and immediately become covered with a heavy cold dew from mere exhaustion, or want of stamina, whilst his fellow, though foaming, is still fresh, active, lively, and entirely master of his work. In point of general health, however, as may easily be conceived, the advantages are most decidedly in favour of the thus prepared food fed horse, whose powers of digestion are thereby greatly assisted, without being improperly stimulated or overcome. Moreover, his hours of rest are nearly doubled. He, having so readily refreshed himself, lies down to repose, whilst his less fortunate though equally deserving compeer, must remain for hours on his weary limbs ere he can possibly appease the cravings of hunger from a crib of dry provender, which must undergo many chemical changes in the stomach before it can be rendered equally alimentary as the prepared food of the other, though mostly composed of the very same ingredients. Yet it is not intended by this course of management to pamper the horses, nor to overload their comparatively small stomachs with too much soft food on any occasion. When the horses appear very hungry, or are apt to swallow their mash too fast, only one-half of it or so is given at a time, and the other half, one or two hours thereafter, leaving them in the intervals to partake of their straw or other fodder at pleasure.

Nor is it supposed that such mashes would find favour in hunting stables, although a feed or two of boiled beans would, even there, often prove of greater benefit to some horses, at the close of a long chase, than their ordinary fare. Young colts thrive remarkably well on this food with straw, and even old horses are much healthier with the same feeding in winter, than when kept on cut clover in summer, as this frequently causes the legs of old and idle horses to become *greasy*. Some of the most extensive post-masters, in large provincial towns, have, therefore, adopted the preparing of daily mashes from waste hay-seed, and other sweepings of their lofts, stewed with a mixture of turnips, and the cheapest market barley, duly seasoned with salt. The utility of prepared food, then, needs only to be tried in order to be fully appreciated, though its expense must, in every case, be dependant on the quantity and quality of the several articles employed in the preparation. These may consist of one or all of the various descriptions of corn, pulse, and roots usually given to horses, together with such bean, pea, or oat chaff, chopped hay or straw, bran, or other substitute, as may be most conveniently obtained in the locality, and which are all within the reach of *every horse-keeper*, whether a corn-grower or not.

Bean-straw being almost never sold, unless as an entire crop in the field, and, according to the present *town* mode of horse-feeding, is indeed unsalable to any except perhaps a few carters, who may prefer it for a month or two in winter, when hay is high priced, it is, therefore, difficult to fix its real value, although, when constantly used by the farm-horses, it comes in the place of oat-straw or hay. The value of these, again, is scarcely less difficult of adjustment than the other, since every district has its own price for land produce. An approximation may, nevertheless, be made sufficiently near the truth, to afford a comparative estimate of the different modes of keeping farm-horses on dry and prepared food.

To begin, then, by selecting an individual farm of about 120 imperial acres of arable clay-land, wholly under crop or regular culture, where nine horses, old and young, including a brood-mare, colts, &c., are kept throughout the winter, and where the preparation of the mash is always in the charge of one person, (a boy,) who has fixed quantities of each article strictly pointed out to him, by which he proceeds to put into a cast-iron boiler of 70 or 80 gallons imperial measure, as follows:—

22 lbs. of bean-chaff, valued at 8d. per cwt.,	L.0	0	$1\frac{1}{2}$
130 lbs of yellow turnips, — 6d. per cwt.,	0	0	7
7 feeds of small corn and beans, say at 1s. 8d. per bushel or eight feeds,	0	1	$5\frac{1}{2}$
$1\frac{1}{2}$ lbs. of salt, or about $2\frac{1}{2}$ oz to each horse, to which may be added fuel, say in all	0	0	1
Divided among 9 horses, is just 3d. per mash,	L.0	2	3

If hay sells at 3s. per cwt., bean-straw cannot fairly be estimated above 2s. 1d. per cwt.; and finding upon trial that each horse will consume about 22 lbs. of bean-straw per day, when fed on the above mash at night, together with one feed of oats in the morning and another at mid-day, the sum of all these items will be—

22 lbs. of bean-straw, at 2s. 1d. per cwt.,	L.0	0	5
2 feeds of inferior oats per day, at 2s. 2d. per bushel,*	0	0	$6\frac{1}{2}$
1 mash as above,	0	0	3
Daily cost of keeping each horse,	L.0	1	$2\frac{1}{2}$

Now, as this course of keeping continues from the 1st of November to the end of May, or seven months, the gross amount of the preceding account will stand thus:—

210 days on bean-straw, at 22 lbs., or $41\frac{1}{4}$ cwt. at 2s. 1d.,	L.4	5	$11\frac{1}{4}$
210 days' oats, 2 feeds per day, at 2s 2d. per bushel,	5	13	9
210 days' mashes, 1 per day, at 3d. each,	2	12	6
About L.1 : 16s. per month per horse,	L.12	12	$2\frac{1}{4}$

* It need scarcely be here remarked that no farmer does, nor indeed can afford to give his best oats to the horses on almost any occasion.

The next estimate proceeds upon the assumption that the horses are kept the whole of this period on hay and corn, to the total exclusion of mashes. The account will—taking the same scale of prices for oats, and 11d. per cwt. additional on hay, as the difference of its greater market value, if sold from the rick as bean-straw would be from the barn-door—then be—

210 days' hay at 22 lbs. per day, at 3s. per cwt., . . .	L.6 3 9
210 days' oats, 3 feeds per day, at 2s. 2d. per bushel, .	8 10 7½
About L.2 : 2s. per month per horse, . .	L.14 14 4½

But the practical discrepancy must be still greater, inasmuch as the weight of bean-straw is, in ordinary seasons for beans, perhaps twice the weight of an acre of sown grass hay on the same farm; and, if the marketable beans produced on an acre be computed at 20 bushels, at 3s. 6d. per bushel. this will give £3 : 10s. per acre for beans, which is far more than the aftermath of clover would bring. There is also the additional advantage of beans being a much less exhausting crop than clover, which is often twice cut without any extra manuring. Thus shewing the propriety of growing more beans and less clover-hay, or cutting grass, whenever the land is at all fit for beans; and, doubtless, there are many farms where beans would succeed if drilled or ploughed down, on clean deep soils, although not really clay-bottomed land. Drills are preferable, however, to broadcast, as the beans can then be hoed up, and a greater body of earth given to the roots, as well as being easily cleared of weeds. But whatever the system of sowing may be, the land ought to be rolled some time before the beans appear above ground; for bean-land can seldom be too much compressed at this period, if properly prepared at first.

The stewing of barley or oat chaff, with a little corn and turnips, is also generally used in the keeping of farm-dairy cows in winter, along with oat-straw, reserving the hay till the calf is dropped, when this mash is given up, and nourishing dry food supplied to the cows; resuming the mash again, with the addition of bean-meal, together with hay, till the grass or green-food season returns. But especial care is taken not to mix any bean-chaff in the cow-mash, because of its laxative nature, and of its causing the cow to pick calf. Subsequently, however, it may be sparingly mixed with the other chaff quite safely.

This peculiarity of bean-chaff and straw is rather favourable than otherwise to the habits of the horse, which seem to require aperient food, especially in winter.

Bean-chaff is also highly relished by wintering stock in the straw-yard; and the good effects of occasional fodderings of this

chaff, mixed with that of corn-chaff, is very perceptible in the relaxed state of their bowels; and many farmers, having a quantity of the several varieties of chaff left over at the close of the thrashing season, place the whole in an out-house, or the centre of an oat or barley straw stack, duly salted, and secured for next winter, to be then served out to the straw-yard cattle, proving more acceptable to them than any other fodder.

It is thus manifest that, where beans or pease can be alternated with the other crops of the farm, horses cannot possibly have better winter provender than this straw accompanied with mashes; and, doubtless, it would be a great improvement, and more economical, could any means be devised whereby the corn-straw, and all other straw, might be chopped, if desired, at the time of thrashing, as it escapes from the thrashing-machine, without allowing the cut straw and corn to become mixed in the operation, and occupying the corn-floor by the process; for, however convenient straw-cutting machines may be in themselves, they require so much additional time, room, and labour, as to preclude all hope of their ever becoming universal in farm practice. Chopping, or more completely breaking the bean-straw, would certainly prevent much waste in the stables, when the horses naturally select the softest and shortest portions of it, leaving the rest as litter under their feet. On this account, it will probably be objected that a greater allowance per diem of bean-straw ought to have been made in the preceding estimate; but this *apparent* waste is just another proof of the little market-value attached to bean-straw, so that many farmers really allow the horses to litter themselves with it in place of wheat-straw, which sells so well for thatch or litter; and thus a seeming waste becomes, in the end, a source of gain. The truth, however, is, that, with such mashes, horses eat little straw at night, so that the greater part of it remains till next day.

This is demonstrated by the following facts, obtained by inspection of the premises of a most respectable proprietor of one of the largest posting establishments in Scotland, who, after sustaining great loss and much inconvenience from waste of hay, and continual recurrence of sick and unsound horses, has adopted the subjoined system of stable economy with the utmost success. In one corner of the yard, a boiler, containing about 120 gallons imperial measure, is erected under a small shed, containing the pump-well, with stone trough, and a square wooden cooler still more capacious than the boiler. Into this boiler are put 60 lbs. of bran, 320 lbs. of Swedish turnips, and 1½ bushels of barley, to which is added about 7 lbs. of salt, with water sufficient to boil the whole, and the mixture is then covered up and allowed

to simmer till the turnips and barley are quite soft. The boiler is then emptied into the cooler, where the mash remains from four to six hours, according as it may be wanted, and is cooled to about blood-heat. The mash is then distributed at seven or eight o'clock, P.M., when the horses are done up for the night, amongst fifty-four to sixty of them, at the rate of a-half pailfull to each, or a heaped pailfull among three horses, in lieu of a feed of oats, with about 7 lbs. of hay put into each rack or crib. In the morning the horses get a feed of oats about six o'clock, and an hour or two afterwards, each has 10 lbs. of raw turnips, washed and cut, put before him. He gets another feed of oats about mid-day, but nothing more till mash time, if not expected to go out soon. And those horses which are taken out or are on full work, have, in all, four feeds of oats each day, besides their portion of the evening mash and morning turnips. Such is the mode of keeping pursued during the whole winter season, or so soon and so long as turnips can be procured; and certainly nothing can exceed the appearance and condition of the horses, every one being as clean in the skin and lively as any private stud can be, however differently fed or maintained. This mash is given at least five times in the week, or oftener if possible. Nor are the horses doing the hardest, late and early, wet and dry work, (stage coaching,) found more easily heated or tender than before, but, on the contrary, are remarkably robust, active, and lively, far less liable to sickness or swelling of the legs than is so common with post-horses kept entirely on hay and oats. The actual difference, however, as to expense, between the two modes of keeping, though considerable, as will be seen below, is not so material as the fact of assured health, and consequently much greater length of active service, than on the old system.

The cost of this mash is—

60 lbs. of beans, at 70s. per ton, ...	L.0	1	10¼
1½ bushels, of inferior barley, 3s. 3 l. per bushel, . .	0	4	10½
320 lbs. of Swedish turnips, at 14s. per ton, ...	0	2	0
7 lbs. of salt, or nearly 2 oz. to each horse, also fuel and attendance, ...	0	0	5
	L.0	9	2

Being about 2d. per mash to each of fifty-four horses, whilst the feed of oats thus superseded would cost 3½d. But the saving chiefly lies in the small quantity of hay required by the horses thus maintained, which is only 7 lbs. in twenty-four hours; whereas formerly each horse had his rack continually filled with hay, (where it soon became tainted by his breath,) and ate or wasted fully three times that quantity, or about 21 lbs. per day, in addition to all the oats. Now, taking the hay at 19 lbs.

per day to each horse, at 3s. per cwt., and the oats at 2s. 5d. per bushel, the account will stand thus—

19 lbs. of hay, at 3s. per cwt., ...	L.0	0	6
5 feeds of oats, (8 to the bushel,) at 2s. 5d. per bushel,	0	1	6
Twenty-four hours' keep of one horse on full work,	L.0	2	0

Per Contra.

7 lbs. of hay per day, at 3s. per cwt, ...	L.0	0	2¼
4 feeds of oats, at 2s. 5d per bushel, ...	0	1	2½
10 lbs. of raw turnips, at 14s. per ton, ...	0	0	0¾
1 mash as above, ...	0	0	2
Twenty-four hours' keep of one horse on the same work,	L.0	1	7½

Making a positive saving of 4½d. per day on the keeping of each horse, or L.2 : 8 : 9 on the six months of twenty-six weeks, at five mashes per week.

The *stewing* is thus most decidedly preferable to the *steaming* system of preparing horse food, obviously because the former preserves all the *juices* of every ingredient employed, whilst the latter allows those juices to escape from beneath ;* and which, in reference to *potatoes*, is proper enough, but with other roots or vegetable productions is absolute loss. Besides, the universality of turnip and carrot culture, particularly turnips, which can now be produced on almost any soil and in every locality, renders the potato no longer an object of attention as horse food in any form ; for it is not only inferior to these mashes in point of palatableness to the horse, but is also dangerous if given raw, often causing gripes, colic, and sudden death, as might easily be proved by facts of actual occurrence, were it here necessary. Potatoes may therefore be with great propriety excluded, and are already prohibited by many farmers from the dietary of the horse.†

Nor ought raw turnips or carrots to be given unwashed, or in larger quantities than 10 to 14 lbs. at a time, or at other times than when horses are cool, and have some dry food on their stomachs ; that is, in the morning before going to work. In this form turnips and carrots serve partly for water as well as food, just in the same way that the evening mash prevents horses from drinking so much cold water next morning as they would otherwise do if wholly restricted to dry food. This of itself is no trifling consideration, especially in the spring season, when the poor horse is so hard pushed from day to day, under a drying

* No kind of grain, or straw, or chaff *can* be cooked by steaming, that process having the invariable effect of burning or charring those ingredients.—Ed.

† Even steamed potatoes, if constantly administered, have been found to act injuriously on the pulmonary system of the work horse.—Ed.

sun and wind, and when large or hasty supplies of cold water so frequently prove fatal to him.

Other instances might here be given, and additional facts adduced, illustrative of the same principle, and of the propriety of interchanging prepared food with dry provender to the horse in one form or another, as the circumstances of the case, the produce of the farm, or the prudence of parties may render most expedient. But it is conceived to be unnecessary to enlarge upon a subject so plainly dependant in practice on so many minor considerations, all more or less likely to influence individuals as to its adoption or final rejection. Change of food, as all know, is not less grateful or essential to the horse than to other animals, and of all animals the horse is most fastidious in the selection of suitable, and most readily affected by improper, food or water.

It is almost superfluous to attempt estimating with exact precision the summer keeping of farm-horses, seeing that locality alone must determine this point, every district having its own practice of retaining the horses in the stable at night or putting them into the fields for a month or two at mid-summer. Both practices have their advantages and disadvantages. Where horses are pretty regularly employed on green-crops, or fallow work, or carting lime, it is evidently much better for them to be kept in the stable over night, and supplied with green food, than to be turned out to experience the vicissitudes of the weather, after being heated in the yoke, even though they do remain some time to cool in the stable; and, besides, they cannot refresh themselves so well and so fully as would be the case were they provided with their usual shelter along with their necessary forage. There is also a great loss of manure by the pasturing of horses, besides their requiring more ground for that than would suffice to raise a cultivated crop of forage. The pasture, too, must always be near the farm-stead, well sheltered, dry bottomed, and properly watered, to render it really available. These, and many similar considerations, combine to prevent farm-horses on heavy lands or exposed situations from ever being turned out at night, or even through the day, except occasionally on Sundays. On lighter and warmer soils, however, where there is less summer work, the horses will unquestionably be much healthier to remain out than be comparatively idle in the house day and night, unless they have a proper fold-yard to exercise and rest in.

The expense of summer keeping for farm-horses, as already remarked, must, therefore, be as various as that of winter, as the modes or means adopted are within the reach of the owner—the extent of forage, number of horses, and the nature of their employment. With his present resources, however, there seems to be no other course of summer management left to the heavy-land farmer than that now generally followed of cutting clover

or tares for the horses, as early and as long as these can safely be used as green forage; for either plant cut too early would not be profitable nor suitable for hard-working horses. Hence horses are frequently more than seven months on winter food, though, to preserve greater simplicity in the account, their cost of keeping has been taken in entire months.

On the farm to which the first given estimate refers, there are nine horses, including a brood-mare and two colts in winter, and only six horses or three ploughs in summer; their hours of yoke generally being from daylight to dusk in winter at the plough, thrashing-machine, or carts, with one hour at mid-day to feed, and from seven A.M. to seven P.M. in spring and summer, with two hours at mid-day for feeding.

The cut grass is generally taken from one side or corner of a field of young clover and rye-grass, (12 lbs. red clover and 1½ bushels annual rye-grass seed per acre.) sown the previous season with the barley, and intended for hay for sale.

It is the first work of the three ploughmen in the morning to proceed to the clover-field about five o'clock, and cut a small cart-load of the grass, which occupies them about an hour, or a little more if two days' grass is required. The grass is taken home, and either remains on the cart in a shady place close to the stable, or, if wet, is spread on the loft above to dry. When the space of ground thus reserved for the horses has been gone over, or the grass gets too ripe and hard to be used green, the remainder is made into hay, and the horses are kept upon cut tares for a time, till the second crop becomes ready for cutting, which is continued to the horses in favourable seasons to the end of October. The quantity of cut grass consumed by each horse necessarily varies with the state of the grass at the time of cutting. When the grass is young and succulent, more of it is required, and when older and hard, the horses eat less and waste more, if allowed to do so by being too liberally supplied at a time.

Taking these things into account, and seeing that a certain degree of waste is unavoidable, be the care and economy what they may, it has been found, by repeated trials, that from 180 to 200 lbs. of cut clover will serve each horse twenty-four hours, one day with another, throughout the grass season. Say 196 lbs., or 1¾ cwts., at 6½d. per cwt., for five calendar months, and five days to complete the year, or 155 days, with one feed of oats to each horse for four months or 120 days, the amount will be this—

155 days of cut grass, at 1¾ cwt. per day, at 6½d. per cwt., .	L.7 6 11
120 feeds of oats, eight to the bushel, at 2s. 2d., ...	1 12 6
Keeping of each horse L 1 : 14 : 6 per month, or during 5⅙ summer months, ...	L.8 19 5

No allowance is here made separately for the tares; because, however nutritious in themselves, or valuable as change of forage, they are so powerfully diuretic, particularly on weakly constitutioned horses, that no more are sown than will serve to make up the usual blank of two or three weeks, between the close of the first and commencement of cutting the second crop of clover. Nor is there any account here taken of the time required to cut the clover, because it occurs in the least busy time of the season, and it is trivial in itself, not exceeding 20s. to 30s. upon the whole period. Nor does it properly belong to such an estimate; because, if the horses do not get cut grass, some other food must be provided for them, or the same time will be wasted in bringing them to and from pasture. A similar remark is applicable to the time of the boy who prepares the mashes for the horses; because, in reality, it forms but a very small part of his daily work. On very large farms, however, it is customary to have the grass cut and carried by an extra man and horse at still less expense.

Thus, then, it is seen that the cost of keeping each horse upon a farm of 120 imperial acres of heavy land, all under crop, is about L.8 : 19 : 5 during the five summer months, and L.12 : 12 : 2¼ for the seven winter months, or in all L.21 : 11 : 7¼, being a saving of L.2 : 2 : 2¼ in favour of bean-straw and boiled mashes as compared to hay and hard corn, for the winter; and a saving of L.2 : 8 : 9 in the case of posting horses for a period of six months; or a clear gain of L.18 : 19 : 8¼ to the farmer on the winter keeping of nine horses, and of L.131 : 12 : 6 to the postmaster on fifty-four horses during winter—no small matter in these times, taken in connexion with the positively improved condition of both classes of horses, and the regular performance of ordinary work in both cases. Otherwise the comparative saving would be of little avail, were the horses not at the same time found equal, and more than equal, to their ordinary work; for no greater error can be committed by any farmer than to allow his horses to fall off for want of nutritious provender, especially in winter, with the prospect of long days of severe spring-labour before them.

It is impossible to quit this very important subject without briefly adverting to the very injudicious practice prevalent in some quarters, of continuing to cut grass after boisterous weather has caused the clover to fall down and wither, or while it is covered with hoar-frost. Nothing can be more improper than this, or fraught with greater danger to the health of horses. How easily and advantageously might every risk be avoided in this by merely watching a dry day, at an earlier period of fine weather, whilst the clover is in full vigour, and cutting and

carting it off after exposure to a day's sun, and placing it in a stack, intermixed, stratum upon stratum, with dry straw of oat, barley, or even wheat, to which a sprinkling of salt should be added, and thus converting the whole into excellent fodder for horses or any other stock, far more profitable than in its original state.

In connexion with farm-horse feeding, for which turnips are so admirably adapted, it may not be out of place here briefly to advert to the most approved mode of storing this invaluable root for winter and spring use, and regarding which much diversity of opinion obtains amongst farmers; for, however convenient it may be in dry upland districts to allow the turnips to remain in the ground till March or April, such a practice is inadmissible in low-lying clay soils, where, besides the inevitable poaching of the land, in carting off the turnips in wet weather, there is the risk of losing great part of the crop, by continued rains or severe frost, it being well known that hoar-frost invariably proves the heaviest in such localities; and should it prove frosty when the spring seed-time arrives, the frozen turnips are necessarily thrown together in large heaps, the probable result of which is, the total loss of the whole so soon as the weather becomes mild, not to mention the danger of giving frozen turnips to cattle. To obviate these evils, and get the land sown with wheat before winter sets in, it is customary in the Vale of Forth to pull as many as possible of the turnips in October and November, and convey them to a convenient corner of a field near the homestead, where they are laid in long heaps on the ground, neatly *trimmed* up by hand, and carefully covered with straw. but not with earth, it being found that the admission of air and moisture is rather advantageous than otherwise to the keeping of turnips, all that is necessary being simply to add more straw in the event of severe frost, and to place a few straw ropes, or pieces of light wood, along the heap, to prevent the wind from removing the straw. Turnips, especially the yellow and Swedish, may thus be preserved quite fresh and firm till June or July. The heaps are turned over and hand-picked whenever the buds begin to assume any size, and re-covered with straw as before. But great care is necessary in *topping* and *tailing*, as well as in handing the turnips into the carts; because too close cutting off of the top or tail, and bruising whilst throwing them into the carts, induce the speedy decay of the turnip in the heap. Every injured turnip. whether *cut*, *burst*, *bruised*, or slightly decayed, should therefore be laid aside at the time of storing or turning over the heap, for the purpose of being first used. The heaps may be arranged in the order in which they are to be used, placing the Swedes farthest off, and shaded from the influence of strong sunshine,

but not in contact with wall or hedge without the intervention of straw, lest the frost should penetrate to the turnips.

Let it be remarked, however, that for the more perfect preparation of horse or cattle food, as exemplified in this essay, much necessarily depends on the construction and position of the boiler-house appropriated to such a purpose. Instead, therefore, of having such boilers pushed into a corner of some little hovel, with scarcely room sufficient to contain the proper apparatus, together with a cart-load or two of coals, or, as is too frequently the case, having the whole exposed in the open air, without any covering or house whatever, to the manifest waste of fuel and danger of igniting the stackyard or other out-buildings; instead of incurring all this waste, risk, and inconvenience, apart from its unsightly appearance, it is easy to select a spare corner at one or other of the angles or openings of any ordinary farm-steading already formed, where the boiler-house, with the necessary appendages, can be safely and conveniently placed.

And where the vacant space is large enough for such purpose, or an entirely new homestead is being erected, a poultry-house, potato-house, and piggery might all be included in the range, or placed contiguous to each other. This arrangement would be found much more economical and convenient to the farmer than the usual one of having the houses in separate positions, and perhaps at a distance from the pump-well or water-course, so indispensable an adjunct to such houses. But the truth of these averments will, perhaps, be rendered still more apparent by a reference to the annexed sketch in Plate IV. of the boiler-house and others on the farm whence the preceding essay and estimates originated—a farm where all the main buildings were erected upwards of fifty years ago, and forming a square, with the dwelling-house on the south, the barn on the west, the granary over the cart-shed on the north, and the stable and byre on the east side, each side detached or separated from the other by an opening or thoroughfare at the four angles. The boiler-house was originally a mere hovel—the poultry had no other roost than the usual "*cork-loft*" over the cows—the ducks lodged as they best might in the cart-shed, or other less secure places, and the potatoes were kept in a corner of the cowhouse, as also the pigs. Finding the great inconvenience and positive loss attending this want of proper accommodation, an effort was made several years since to have it remedied, and, partly at the expense of the landlord and that of the tenant, entirely new places were provided for all these purposes, agreeably to the plan. First the boiler-house, Fig. 1,

embracing the whole space parallel to the byre gable, with which it nearly forms a square, being about 19 feet by 18½ feet within walls; the walls are 11 feet high, with a store-room or loft overhead, for the purpose of holding small corn, bruised grain, and the like, for the boiler. The centre or south door of the boiler-house is placed over a tank or well, about 15 feet deep by about 6 feet diameter, dug out of the clay subsoil, bottomed and built round with stones, to serve as a reservoir, which is supplied with water by means of a small tile tube-drain, communicating with a horse-pond some 30 yards distant. The well is covered with a thick stone slab, into the one side of which a pump, *a*, is placed, with a folding door shutting in the whole, but so wide as to admit of the pump and slab being removed at any required time. This pump, thus secured from frost or injury, serves the boilers, the washing of turnips, potatoes, or other roots, watering of live stock by hand-pails, besides supplying the water-trough in the strawyard; and, in short, every other domestic purpose, except for human food.

The boilers are placed on each side of the chimney, *c*, at *b b*, the one for horses, the other for cows, from which the flues convey the smoke, and the furnaces are in front, at *b b*.

Each boiler has a wooden cover as in Fig. 2, made double, with transverse inch boards, to prevent their casting or twisting, the upper part resting on the edge of the boiler, whilst the under side falls within the margin. The back segment of these covers is fastened to the rim of the boiler by means of three small-pointed iron brackets, equidistantly nailed on the under side of the segment, and passing into corresponding holes near the lip of the boiler. Two hinges, *k*, are placed on the upper side of the covers, by which they are moved up and down at pleasure. The superfluous steam is conducted from the fixed part of the covers into the chimney, by a three-inch sheet-iron tube, as shown by *l l*. The figure represents one boiler with the cover *up* or open, and the other *down* or shut. This is an essential point, as tending to save fuel as well as to preserve the interior of the boiler-house and connected apartments from the injurious effects of a constant cloud of dense steam issuing from each boiler when in use.

Opposite to the boilers is the coal-place, Fig. 1, with a parapet wall, and in front of the pump is the *sink* or gutter, *e*, for the waste and dirty water passing into the *cess*-pool, *f*, and thence into the main drain, which has an opening or latch, at *g*.

The back-door on the right leads to the piggeries and straw-yard, in which a water-trough, *i*, stands, and is supplied with water, as required, from the boiler-house pump, by means of

a movable *run*, crossing the front door, and thence conducted, by a fixed three-inch iron pipe, round the angle of the coal-place, passing through the east wall and also the piggeries, and falling into the trough through the south wall of the straw-yard.

The corner door on the left leads to the court-yard of the farm, as well as into the poultry and potato houses.

The poultry-house is placed next the boiler-house, because of the constant warmth required by its feathered tenants, and the greater coolness necessary for the potato-house, three sides of the poultry-house being six-inch brick walls, with a south window, whilst the potato-house has three sides of stone walls, and requires no window.

There is a loft on each side of the poultry-house, as shewn by Fig. 3, placed about six feet above the ground-floor, and over the centre space is placed a light stage let into the front wall about 3½ feet above the side-lofts at one end, and resting on two upright posts placed in the partition at the door at the other end, with four straps of wood nailed to the sides, and fastened to the roof above. The object of this stage, which is considerably broader than the space between the two lower lofts, is to intercept the droppings from the hen-roost still higher up, and which, with the two side-lofts, thus preserve the floor always clean, excepting what arises from a few ducks sitting below. Along the face of the brick walls, both above and below the side-lofts, are several tiers of *square holes*, at *m m*, formed of thin boards for the hens' nests, and the window is furnished with a wire screen to preserve the glass from accidents. The position of these nests are also seen at *m m* in the poultry-house, Fig. 1; *n* is the stair to the loft above the boiler-house. The potato-house has no extra fitting, and the piggery is only about 7 or 8 feet in height, covered with stone pavement. The poultry-house and potato-house would have been made larger had the space admitted of it, without curtailing the dimensions of the boiler-house. And although these several appartments are thus placed at a corner of the original homestead, and actually connect the dwelling-house with the byre and stable range of buildings, yet, *internally*, each of the houses is still as disconnected by thick stone walls as formerly. Nor are the roofs at any point united; for, besides being in the pavilion form, the roof of the new houses is several feet lower than that of the byre or dwelling-house. The roof is slated, and the whole buildings cost about £75, exclusive of the piggery.

RETURNS to the HIGHLAND and AGRICULTURAL SOCIETY of SCOTLAND of COMPETITIONS in SEED for CORN and other CROPS, held in the Year 1845.

Districts.	Seed Exhibited in Competition by Growers to whom Silver Medals were Awarded: Names of Species and Varieties	Quantity Qrs.	Value of Awards £	s	d	Competitors to whom Silver Medals were Awarded: Christian Name and Surname	Estate or Farm and Post Town		Produce per Acre Qr	Weight per Bushel lbs	oz	Date of Sowing	Date of Reaping	Ground on which the Prize Seed was Grown: Height Feet	Exposure	Nature of Soil	REMARKS
Lower District of Annandale	Potato Oat,	3	3	2	0	Mr Bradshaw Barker,	Wyseby Mains,	Ecclefechan,	$4\frac{1}{2}$	45	12	Mar 29, 1844	Sept 2, 1844	200	S W	Light loam	
	Perennial Rye grass,	2	3	2	0	Mr W Wilson, land steward to Mr Currie of Stapleton,	Stapleton, .	Annan, .	$3\frac{1}{2}$	26	0	Apr, 1843	July	100	S E	Clayey loam	
County of Nairn	Common Barley, .	3	3	2	5	Wm Mackintosh, Esq	Geddes,	Nairn, .	5	50	$11\frac{1}{2}$	Mar 26, 1844	Aug 20	150	N	Blck lm undrained	
	Late Oat, Grey Angus,	3	3	2	5	Wm Mackintosh, Esq	Geddes,	Nairn,	5	46	4	Mar 28	Sept 6	150	do	do do	
	Early Oat, Sandy,	3	3	2	5	Mr Alex Walker,	Brightmony,	Nairn,	5	47	$5\frac{1}{2}$	Apr 4	Sept 1	200	do	Dark loam do	
	Perennial Rye grass,	2	3	2	5	Wm Mackintosh, Esq	Geddes,	Nairn,		29	4				do	Black loam do	a Cut before fully ripe b Sown 11 days later and cut 8 days earlier than Hopetoun Oats with south aspect and shelter from N E winds c Grown within 400 yards of the sea d Of 12 bushels of seed sown after having been steeped for eight hours in old urine and then dusted with a little lime not one grain germinated e Grown on the farm of Linton bog parish of West Linton
District of Dalkeith	Potato Oat, .	10	6	2	0	Mr George Watson,	Libberton Mains,	Libberton,	$7\frac{1}{4}$	46	0	Mar 25 ..	Aug 13	300	do	Light and dry *a*	
	Hopetoun Oat,	10	3	2	0	Mr Robert Cross, .	Hilltown,	Dalkeith,	6	43	0	Mar	Aug .	170	do	A good wheat soil and rather stiff	
	Early Oat, Sandy,	10	6	2	0	Mr Alex Stenhouse,	Whitehill Mains,	Dalkeith,	$9\frac{1}{2}$	43	9	Apr 10	Aug 30 ..	150	N W	Dp lm with retentive subsoil *b*	
	Late Oat, Grey Angus,	10	5	2	0	Mr David Scott, jun	Northfield,	Portobello,	11	41	0	Mar 20 ..	Sep 5, 6	50	S L	Clayey loam *c*	
	Chevalier Barley, .	10	9	2	0	Mr John Proudfoot,	Pinkiehill,	Musselburgh,	$7\frac{1}{4}$	57	8	Apr 2	Aug 22		S	Light, upon a gravelly subsoil *d*	
	Scotch Barley,	10	5	2	0	Mr Robert Cross,	Hilltown,	Dalkeith,	7	56	0	Apr .	Aug ..	150	S E	A good free soil and well adapted for green crop	
	Don Potato,	To 2	4	2	0	Mr John Wilson,	Bells Law,	Dalkeith,	T 10			Apr 15	Oct 15	780		Light, rather mossy & drained *e*	

HIGHLAND AND AGRICULTURAL SOCIETY'S HALL,
EDINBURGH, 12th *August* 1845.

By Order of the Directors,

CHARLES GORDON, *Secretary.*

REPORT ON PLANTATIONS on the ESTATES of His Grace the DUKE of RICHMOND in the COUNTY of ABERDEEN.

By Mr George M'Pherson, Huntly.

[Premium—The Gold Medal.]

These plantations were formed between March 1839 and May 1844, and they extend over a space of 2,442 imperial acres. Thus—

1st, Binhill and adjacent moors, 2,258 imperial acres, besides 45 acres occupied by a peat-moss and a road leading to the same.

2d, Hill of Drumdelzie, 117 imperial acres, lying in the immediate vicinity of the above, and, in fact, a portion of the same moors.

3d, Culdrain plantation, 41 imperial acres, being a detached piece of planting lying in the parish of Garthy, and not specially adverted to in the following report.

4th, Various clumps and belts in different portions of this district of his Grace's property, for the ornament and shelter of different farms, 26 imperial acres.

The Binhill and adjoining moors are situated in the parishes of Cairnie and Huntly in Aberdeenshire, and are distant from the town of Huntly about one mile. They extend from the turnpike road leading from Huntly to Keith on the west, to the turnpike road leading from Huntly to Portsoy on the east, measuring in one straight line $2\frac{3}{4}$ miles, and from north to south at the widest extremities about $2\frac{1}{4}$ miles.

The ground is much diversified, presenting a variety of irregular rocky hills, known as the Binhill, Ordquhill, Clean Cairn, Boddamhill, Ordhill, and its elevation varies from 300 to 1000 feet above the level of the sea.

The surface of the ground is either rocky, or covered with earth-fast stones, some of them of immense size, measuring over the top from 30 to 50 links. It was thus altogether unsuitable for tillage, and, until planted, had been pastured as a common by the sheep and cattle principally of the smaller tenants and crofters adjacent.

As might be expected on such an extent, the diversity in the kind and quality of the soil is very considerable. Many parts, particularly of the eastern slopes, are composed of a rich brown loam, well adapted for the growth of hard wood. In some of the lower level parts there are deposits of peat, but only to any considerable extent in the hollow which intersects the planta-

tion and divides the Binhill from Ordquhill. The greater portion may be termed a good moor soil, with scarcely any traces of moor-band, or that poor, dry, black heathy peat, so common in many similar altitudes.

Before being drained there were considerable portions of marshy ground, particularly in the Ordquhill division and on the north and west sides of the Binhill. A very great extent, however, of surface-drainage was effected in these parts, which now, instead of acting as reservoirs of rain-water, are relieved of the superabundant moisture as it falls, often with a rapidity somewhat inconvenient for those whose thrashing-mills a slower and more constant discharge would suit much better.

The admirable adaptation of the greater portion of this large tract of waste ground for the growth of most of the common forest trees, the scarcity of timber, both for agricultural and other purposes in the district, and the manifest advantages which it would afford both as shelter and ornament to a surrounding district of no inconsiderable fertility, and of rapidly advancing improvement, induced the proprietors of the Gordon estates, for a number of years, to reserve this tract for planting. Shortly after the succession of the Duke of Richmond to these estates, his Grace resolved to carry that purpose into effect; and, in 1838, Messrs Beattie and Walker, land-surveyors in Aberdeen, were employed to make a survey and plan of the ground, and to prepare specifications of the work, of which the following is a copy:—

Specifications of the manner of Planting the Binhill and adjacent Moors.

The ground is divided into lots, to be contracted for either separately or together. There are several varieties of soil interspersed with one another, which are classed for planting in the following order:—

Class I.—Wet gravelly clay, retentive of water. Distinguishable by greenish benty grass.

Class II.—Deep, rich, damp soil, some parts swampy. Distinguishable by a greensward, with open long heather.

Class III.—Friable loamy soil on the low grounds, on a dry porous subsoil. Distinguishable by short open heather, with an under greensward of the finer grasses; contrasts in colour, and is interspersed with Class I., in irregular patches of small rising grounds.

Class IV.—High grounds, parts of which are very rocky, with friable loamy soil of good quality, partly exposed, and partly sheltered. Distinguishable by short open heather, with green

underswaru; soil light and soft, of a brown or yellow colour; high rocky ridges, and sheltered ravines and hollows.

Class V.—Banks along the base of the rising grounds, and along the turnpike roads, adapted for hard wood. Distinguishable by a deep soil, with short heather or greensward, some parts growing ferns.

The ground above described is to be planted with trees of the following descriptions:—

Class I.—With seedling larch and Scots fir, 2 years old, mixed in equal quantities.

Class II.—With spruce and silver firs, 3 years old, from the seed-bed.

Class III.—With Scots firs only, 2 years old seedlings.

Class IV.—With larch, 2 years old seedlings.

Class V.—With hard woods, oak, elm, ash, birch, beech, in equal quantities, with a few planes, chestnut, maple, and others, for ornament, along the turnpike roads, all to be 4 years old, and transplanted two years. The oak and elm to be planted in the finest soil; the ash in damp and low land; the birch and beech in the greatest quantities on the higher grounds, and a mixture of two years transplanted larch, Scots firs, and spruce.

The plants must all be healthy, strong, full-budded, and fibrous rooted, and the several kinds as uniform in size as possible. The 2 year old seedlings to be planted with the planting-spade or dibble; the spruce and two years transplanted firs with the garden spade; the hard wood to be planted in pits of 16 inches wide by 12 inches deep, properly prepared at least two months previous to planting. The pits to be executed by the contractor, and the expense included in his estimate. The plants and manner of executing the work to be subject to the approval of the employer's inspector.

The contractor must become bound to furnish the plants, execute the planting and pitting, and perform all carriages, with every attending expense relative thereto, by the 20th of December 1839. Also to uphold the planting for the period of four years after the whole is completed, by planting up blanks or parts where the trees may be found unhealthy, when called upon to do so, with plants of the same age and description as formerly planted.

Estimates to be given for each lot separately, per slump sum, in terms of the above specifications and following table, and the contractor must grant security for his implementing the bargain, and payments will be given as the work proceeds, on the order of Mr James F. Beattie, land-surveyor in Aberdeen, to whose satisfaction the work must be completed and upheld for the period above stated,

Table shewing the Extent of each Lot and Number of Trees to be Planted.

Classes of Soil as described above	Description of Trees	Lot 1. N.W. side of Binhill.			Lot 2. S.W. side of Binhill.			Lot 3. N. side of Binhill			Lot 4 E. side of Binhill			Lot 5. N Ordquhill.			Lot 6. S. Ordquhill.			Lot 7. Boddamhill.		
		Number per Acre	Extent, Imperial Acres	Total Number of Trees	Number per Acre	Extent Imperial Acres	Total Number of Trees	Number per Acre	Extent, Imperial Acres	Total Number of Trees	Number per Acre	Extent, Imperial Acres	Total Number of Trees	Number per Acre	Extent, Imperial Acres	Total Number of Trees	Number per Acre	Extent, Imperial Acres	Total Number of Trees	Number per Acre	Extent, Imperial Acres	Total Number of Trees
			A R F			A R F			A R			A R F			A R F			A R			A R.	
I.	Scots Firs and Larch, 2 years seedlings,	3,000	240 2 6	721,612	3,000	205 3 34	617,888	3,000	150 0	450,000	3,000	206 2 18	619,837	3,000	220 1 23	661,180	3,000	307 3	923,250	3,000	60 3	182,250
II	Spruce, 3 years old seedlings,	2,500	40 0 0	100,000	2,500	5 0 0	12,500	2,500	40 0	100,000	2,500	50 0 0	125,000	2,500	40 0 0	100,000	2,500	40 0	100,000	2,500	20 0	50,000
III.	Scots Firs, 2 years old do,	3,000	40 0 0	120,000	2,500	20 0 0	50,000	2,500	55 0	137,500	2,500	40 0 0	100 000	2,500	30 0 0	75,000	2,500	60 0	150,000	2,500	8 0	20,000
IV. Exposed	Larch, do	3,000	30 0 0	90,000	3,000	20 0 0	60,000	3,000	15 2	46,500	3,000	30 0 0	90,000	3,000	10 0 0	30,000	3,000	20 0	60,000	3,000	20 0	60,000
Shelter'd	Do do.	2,500	14 0 0	35,000	2,500	12 0 0	30,000	2,500	13 0	32,500	2,500	16 0 0	40,000	2,500	25 0 0	62,500	2,500	40 0	100,000	2,500	17 0	42,500
V	Hardwood, 4 years transplanted,	500	4 0 0	2 000	500	30 0 0	15,000	..	..	.	500	20 0 0	10,000	500	10 0 0	5,000	500	21 0	10,500	500	10 0	5,000
	Larch, 2 years do	750		3,000	750		22,000	..	..	.	750		15,000	750		7,500	750		15,750	750		7,500
	Scots Firs & Spruce do.,	750		3,000	750		22,000	..	..	..	750		15,005	750		7,500	750		15,750	750		7,500
			368 2 6	1,074,612		292 3 34	830,388		273 2	766,500		362 2 18	1,014,837		335 1 23	948,680		488 3	1,377,250		135 3	374,750

Total, . . Acres 2,257 : 2 : 1. Trees 6,387,017.

and if any difference or misunderstanding arise between the employer and contractor as to the meaning of the above specifications, the same to be referred to the said Mr James F. Beattie, or to any other competent person, to be named by the sheriff of the county, whose decision shall be final and binding on both parties. The employer will fence the ground, and cut such ditches and drains as he may think necessary; also clear off the brush-wood and whins.

200 yards from the line of the exterior fence are reserved during the summer for supplying materials for building the fence; and to be planted in autumn.

Contracts were thereafter advertised for, and six offers for planting, either the whole or a portion of the ground, having been received, an agreement was entered into with Messrs Peter Lawson and Son, seedsmen to the Highland and Agricultural Society, Edinburgh, who contracted to execute the whole work for the sum of £1956 sterling, payable on 15th May and 20th December 1839, and 15th May and 20th December 1840, in the proportion of the amount of work completed at the foresaid dates respectively, to be ascertained by an inspector named in the contract, but deducting from the last payment the sum of £100, which were stipulated to be retained for five years from 20th December 1840, and then paid with interest, at 3 per cent. per annum, on a certificate by the said inspector that Messrs Lawson and Son had completed their part of the contract.

The planting having been thus agreed to, the ground was enclosed with stone fences in the shape of what is called a Galloway or rickle dyke, 3½ feet high, the large stones composing the fence being firmly but roughly put together, the angular points projecting in such a way as to present a far more formidable obstacle to either cattle or sheep than a more regularly built dyke of the same height. These fences, at 6d. per yard, cost in all, carriage of materials included, £464 : 4 : 3.

At the same time, the wet part of the ground, which may be estimated at one-half of the whole, was surface-drained, by small drains cut diagonally across the slopes, and directed into the natural hollows or streamlets. These drains were from 1 to 2 feet deep, 1 foot wide in the bottom, from 18 inches to 3 feet wide at the top, according to the depth; the surface was cut into turf, which was laid regularly along the lower edge of the drain, leaving a scarcement of about 6 inches, the earth being thrown on the turf. This part of the work was mostly executed by labourers at day's wages, under the constant superintendence of an overseer, and cost £225 : 15 : 7.

A road, 15 feet wide, having a ditch and turf fence on one

side, and a smaller ditch on the other side, was also executed, at a cost of £180, for the purpose of giving access to the moss, from which a number of the surrounding tenants obtain fuel, and also of ultimately facilitating the driving of timber out of the wood when it should require thinning. The alders and whins, also, were grubbed up on various parts of the ground, where they would have interfered with the trees specified to be planted, at a cost of £54 : 0 : 9. The labourers were employed at this work at day's wages, under the superintendence of an overseer.

The total expense was as under :—

1.	Estimate for planting, ...	£1 956	0	0
2.	Enclosing, at 6 l. per yard, . . .	464	4	3
3.	Making road, ...	180	0	0
4.	Draining, ...	225	15	7
5.	Grubbing up alders and whins, . .	54	0	9
6.	Expense of survey, &c. . . .	76	12	11
	Total, ...	£2 956	13	6

Or very nearly £1 : 6 : $2\frac{1}{4}$ per acre.

All necessary arrangements having been completed, Messrs Lawson commenced planting the Boddamhill Lot, 7, in March 1839, and when they ceased planting in May, had completed the whole of Lots 7, 2, 3, and 4, except an irregular belt round the outsides, left to furnish stones for the fence dykes, as also fully more than the half of Lot 1. In November following they resumed planting, and, the weather proving very favourable, were enabled to complete the whole by the 20th December, with the exception of a very few acres in parts where the fences were not altogether completed. During the period they were engaged in the work, Messrs Lawson had in their employment from 50 to 80 men and boys.

With the exception of the hard wood and larger transplanted coniferæ, all the plants were put in by means of the planting-iron, and, being so small as scarcely to be observed among the heather and herbage, the planters, to ensure regularity in their operations, were divided into bands of from 12 to 20, stationed at the proper distance apart, and preceded by a boy, whose duties were to measure and mark off the ground by *two* or *three* lines of white pins, according as the number of planters and the nature of the ground made necessary. Each band was also followed by a foreman, to see that the work was done in a regular and efficient manner. The masses of larch, Scots fir, and spruce, were irregularly blended together, to prevent all stiffness in their outlines, often consequent upon the dibble or hand-iron planting of small trees, and care was taken, as far as possible, to arrange so as the planters should move *across* the lines of view from the

public roads and particular points in the surrounding country; and certain previously formed peat-moss roads through various parts of the country were left unplanted, both for the purpose of continuing convenient access to fuel to those localities which the new-made road above noticed did not suit, and for the purpose of ultimately affording facilities for the removal of the timber. These roads, however, are by no means sufficient in number for the latter purpose, and it is therefore intended, in the course of two or three years, to mark and clear off the wood in proper lines with this view, leaving the more laborious operations of levelling, &c., till the roads are actually required.

In October 1840 the state of the various divisions of the plantation were, after a minute and careful examination, reported on as follows:—

Lot 1. Contains by far the greatest portion of inferior wet soil, which, from its stony and shallow nature, would never repay thorough draining. A few additional drains might, however, be made in the peaty grounds opposite the Manse of Cairnie, as well as in some small portions between the manse and the higher parts of the hill, and eastward in the direction of Mortlach.

Lot 2. Also contains some very inferior wet ground east from Binside, together with a good deal that would be the better for more complete draining, particularly that corner where the plantation joins the Inverness road, the flat marshy ground between the same and the higher parts of the hill, a small marsh behind the *Cave Craig*, and several pieces along the south side, near the road.

Lot 3. Is still wet in several parts inside the east dyke and in the large hollow north-east of the summit of the Binhill.

Lot 4. Will still require a considerable number of short drains in all the hollows along the east slope, or next the Moss-side road, as well as in the marsh on the higher ground north-west of Ordhill, and downwards to where the alders grow on the side of the Inverness road.

Lot 5. A considerable number of drains will still require to be introduced in the marshy ground east from Widow Watt's house, and downwards in the direction of Haggieshall, as also along the Portsoy road, and in the small corner on the east side thereof. In the damp parts of this and the next lot the young Scots firs have suffered more than anywhere else, and will require to be replanted in spring.

Lot 6. Will still require considerable additional draining in the large marsh below the top of Ordquhill and Roddentree, as also eastward and along the side of the Portsoy turnpike road. Another marsh of considerable extent, in a line between the summit of Ordquhill and Ordhill, commencing pretty high on

the former and diverging towards the line of an old road from Boghead Park towards William Dawson's, in Lot 5, is still very wet, and a considerable addition of good soil for trees would be gained by forming the proposed cut through the moss, and drying the adjacent cut by means of side drains, a considerable portion of which was planted last spring, but has failed in consequence of the extreme moisture.

Lot 7. Is, on the whole, pretty dry, but would be the better for a few additional drains at the south and north corners, as well as in the old park north of Boghead.

At the date of this report, the plantation was considered as thriving pretty well, unless in the marshy places, and in those portions where the process of planting had been continued too long into spring, and where the plants suffered considerably when the drought set in. In consequence of the remarks in this report in reference to draining, a considerable additional outlay to that originally made was incurred in effecting the drains pointed out, the expense of which, however, is included in the statement given above.

After finishing the first planting in December 1839, a few scores of a thousand plants continued to be put in from time to time, where the failures appeared most evident; but it was not until the spring of 1842 that the "beeting up" was regularly commenced. This was done in March and April of that year, most of the ground planted in 1839 being gone over, the number of plants required for that purpose being from a-fourth to a-third of that originally planted. In the following spring the remainder was completed, chiefly in the eastern or Ordquhill division, in many parts of which the proportion of failures was considerably greater than in other portions of the ground, arising partly from the wet nature of the ground, from the planting having been executed when the autumn rains had saturated the soil with water, before the draining had been thoroughly completed—partly from the strong growth of herbage which the superior nature of the soil had in many places yielded, and for which the plants originally specified proved too small—and partly also from the severe drought which followed the planting in spring. In replanting these portions, one and two years transplanted larch and Scots fir, and two and three years transplanted Norway spruce, were used.

In May 1844, the various divisions of the ground were again minutely gone over, and the following report made on their condition.

Lot 1. *About 368½ acres on the north-west or Carnie side of the Binhill.* Towards the north-east side of this lot there are from 40 to 50 acres of rough sedgy and wettish ground, in which

the existing trees are about one-fourth deficient, or, in all, about 30,000.

Lot 2. *About* 293 *acres on the south-west of the Binhill.* The plants in this division are, upon the whole, in a very satisfactory and thriving condition; but about 4,000 will still be required to thicken 5 or 6 acres of wettish ground, principally situated near the top of the hill, and contiguous to the east boundary line.

Lot 3. *About* 213 *acres on the north and north-east side of the Binhill.* Will require making up to about the same extent as the last—4,000—chiefly on wettish ground contiguous to the next lot; all the young plants here, but especially the Scots firs, are doing remarkably well.

Lot 4. *About* 362½ *acres on the east and south-east side of Binhill.* In several wettish patches towards the lower parts of the ground, containing in all about 12 or 15 acres, plants to the extent of about one-fourth, say 10,000, will still be necessary to make up deficiencies to the originally required thickness.

Lot 5. *Northern Ordquhill division, measuring about* 335 *acres.* In this lot the greatest failures of young plants have taken place, extending over from 20 to 25 acres of damp and very rough sedgy ground, formerly a very wet marsh. About 12 acres in this lot will still require fully half the originally specified number of plants, or 18,000, and the remainder about one-fourth, or 10,000, in all 28,000.

Lot 6. *Southern Ordquhill division, containing* 488 *acres or thereby.* Over the whole of this division not more than 8 or 10 acres now require thickening up, for which 8,000 plants will be sufficient. These deficiencies are chiefly confined to two parts, viz., the top of a large tract of damp rough sedgy ground on the east, and another tract of similar ground on the west side of the ridge, lying between the top of the hill and Cleanpool. It may be remarked that the natural unsuitableness of a great portion of this division (situated within view of Huntly Lodge) for seedling plants induced the contractors, at considerable additional expense to themselves, to use transplanted plants in the drained marshy grounds, throughout which the first planting of seedlings were almost entirely destroyed by the overgrowing herbage and the then prevailing moisture.

Lot 7. *Westertown or Boddamhill, about* 136 *acres.* On the whole of this lot the young plants are doing remarkably well, with the exception of about 5 acres of marsh, called Boghead Park, and another acre or so contiguous to the same, which will still require further drainage in some parts, after which it should be planted with about 3,000 birch, 2,000 alder, 3,000 willows of sorts, and 3,000 poplars of sorts. The last two are best suited

for the parts where the rushes and grass are strongest, the willows being kept as much as possible on parts where the least proportion of peat enters into the composition of the soil.

From the preceding statements it will be seen that about 95,000, or say 100,000 plants (less than a sixtieth part of the originally estimated number) are still required to make up all the parts of the ground to the thickness stated in Mr Beattie's specifications. This quantity, large as it is, must, however, appear trifling, when it is considered that almost the entire deficiency is confined to portions of the ground unsuited for the kinds of plants originally specified, and that at least twice the same extent of ground was of a nature unanswerable for planting with seedlings of the different ages stated in the specifications, the plants having been too small for contending with the strong growth of grass which arose after planting, and which was not calculated on when the land was in an undrained state and constantly in pasture. The consequence of this oversight has been the incurring an additional expense of 260,000 larch, 340,000 Scots fir, and 50,000 spruce, one and two years transplanted.

In concluding this report, Messrs Lawson & Son recommend that the planting should be filled up, in autumn 1845 or spring 1846, with birch and alder at least two years transplanted, except in the case of Lot 7, by which time the plants still living will not only be distinctly seen, but will afford a considerable degree of shelter.

It remains only to be added that, in the past summer of 1844, the plantation has made rapid progress, excepting in those parts of the ground where, from various causes, the plants have failed to some extent, and that the Binhill, and moors adjoining it, already begin to assume something of a clothed appearance.

PROCEEDINGS OF THE AGRICULTURAL CHEMISTRY ASSOCIATION.

The Committee of Management now transmit to the Directors of the Highland and Agricultural Society of Scotland, for publication in the next Number of their Transactions, an Account of some of the Investigations carried on in the Laboratory of the Association since their Report in July 1845.

This account embraces a very small proportion of the analyses made during the last six months by the Chemist of the Asso-

ciation and his assistants, and is intended only to explain some of the more interesting practical results obtained by them in the course of their investigations.

The account has been drawn up by Professor Johnston, in a series of articles applicable to the several subjects noticed, and forming a continuation of those in the two previous reports.

D. HORNE,
Honorary Secretary.

EDINBURGH, 1st *December* 1845.

XI.—OF THE COMPOSITION OF LIQUID MANURE.

The liquid manure of our farm-yards is now attracting more general attention than at any former period, and tanks for collecting it are in course of erection in various parts of the country. Both theory and experiment shew this liquid to be very valuable as a manure, and it has been long known to contain substances fitted in a marked degree to promote the growth of plants. Still, no analyses, so far as I am aware, have hitherto been made of the liquid in the state in which it actually exists in our farm-yards, and in too many cases runs to waste.

It was with much satisfaction, therefore, that I received, a few months ago, two bottles of liquid manure for analysis from Mr Houldsworth of Coltness, near Hamilton, a member of our Association. This gentleman had drawn up, for distribution among his tenantry, a very satisfactory and useful statement in regard to the value of this liquid, and the gain which would accrue from saving it. But, before circulating his paper, he was desirous of having the actual liquor of which he spoke carefully analysed, and he therefore forwarded it to the laboratory of the Association. The examination has led to some interesting results, which I think deserving of general publication.

1°. The liquid contained in the first bottle consisted of the drainings from heaps of cow-dung exposed to rain. It was dark coloured, and, of course, contained only what rain-water is capable of washing out of such dung-heaps. It was neutral, but ammonia was given off when it was boiled, or when quicklime was added.

An imperial gallon of these drainings, when evaporated to dryness, left about 480 grains, or an ounce weight, of dry solid matter. This solid matter consisted of—

Ammonia, ...	9.6 grs.
Organic Matter, ...	200.8
Inorganic Matter, (ash,)	268.8
	479.2 grs.

The inorganic portion consisted of—

Alkaline Salts, ...	207.8 grs.
Phosphates of Lime and Magnesia, with a little Phosphate of Iron, ...	25.1
Carbonate of Lime, ...	18.2
Carbonate of Magnesia and loss, . . .	4.3
Silica and a little Alumina, ...	13.4
	268.8 grs.

From this analysis it appears that the rain is capable of washing out much valuable matter from common cow-dung. The ammonia is not so large in quantity as in many other forms of liquid manure; because most of those substances voided by the cow, which are capable of producing ammonia, pass off in its urine. But, on the other hand, the urine of the cow contains no phosphates, while these washings contain a considerable proportion. It thus appears that the washings of the dung-heaps contain other valuable substances besides those which are present in the urine. Those, therefore, who besides allowing the urine from their byres to run to waste, permit the rain to wash their dung-heaps, suffer a double loss; they lose the ammonia-producing substances, and much alkaline matter in the urine, and the phosphates, with a large additional portion of alkaline matter in the washings.

2°. The second liquid consisted of the drainings of farm-yard dung when watered with cow's urine. It was also neutral, but gave off ammonia copiously when boiled or when mixed with quicklime.

An imperial gallon, when evaporated, left 617½ grains of dry matter, considerably more than the former liquid, and this matter consisted of—

Ammonia, ...	21.5 grs.
Organic Matter, ...	77.6
Inorganic Matter or ash, ...	518.4
	617.5 grs.

We see here that the relative proportions of organic matter in the two liquids were very different. From ordinary farm-yard manure, there is, as we should expect, loss of the organic part dissolved by water than from the finely masticated and digested excretions of the cow.

The inorganic matter contained in this liquid consisted of—

Alkaline Salts, ...	420.4 grs.
Phosphates of Lime and Magnesia,	44.5
Carbonate of Lime, ...	31.1
Carbonate of Magnesia and loss, .	3.4
Silica and a little Alumina, . .	19.0
	518.4 grs.

In this liquid, therefore, as in the other, there was a considerable proportion of phosphates, as well as a large amount of alkaline salts. There are no phosphates in the urine; but the fermentation of the dung-heap, caused partly by the watering with the urine, decomposes the straw and other substances which form the dung-heap, brings a portion of the phosphates they contain into a soluble state, and thus enables them to be washed out by any watery liquid that comes in contact with them.

The urine of the cow, therefore, which has been thrown upon the dung-heap will pass off, if it is allowed to escape, richer than it was at first. It may not contain so much ammonia, or of those substances which produce ammonia, but it will carry away more of those inorganic substances which enter into the composition of our crops, and which are no less necessary to their growth.

XII.—CAN THE FERTILIZING SUBSTANCES BE EXTRACTED FROM LIQUID MANURE?

The insertion of the above analyses leads me to advert to a question which has several times been put to me by members of the Association, and which has been specially recommended to my consideration by the Committee of management. Liquid manure is of large bulk, is expensive to carry to the field, and cannot be applied at every season of the year. Is it not possible, therefore, to extract from it all the fertilizing substances it contains, and to preserve them in a dry and portable state for after use? Could such an object as this be effected, it would be a valuable boon to the practical man, and, in leading to a more general saving of the liquid manure, would not be without its value to the state.

But that a method for thus extracting the virtues of liquid manure may be of use several conditions are required. Thus—

1°. It must be perfectly efficient. If a method were recommended which should merely separate one portion of the substances or one kind of matter from liquid manure, while it left the rest behind, it would only lead to a more general waste than now exists, in so far as it would induce many to believe that, a part being thus extracted, the fluid which was left might be allowed more freely to run to waste.

2°. It must be easy of execution. A process which involves much trouble would not generally be adopted by practical men, and if it were difficult to perform, it would be imperfectly done. These drawbacks would cause the method to fail; it would consequently fall into disrepute, and the advantages of scientific knowledge and skill would sink in public estimation.

3°. The materials employed for the purpose must be abundant,

cheap, and easily accessible everywhere. This is the most difficult condition to fulfil, and it presents the greatest bar to the introduction of any economically useful method of effecting the object in view.

The only substance at present known, by which the separation of all the valuable ingredients from liquid manure can be fully effected, is animal charcoal. A sufficient supply of this substance, when intimately mixed with the liquid manure, will take up nearly the whole of the saline and colouring matters it holds in solution, will carry down the substances it holds in suspension, and will leave the water nearly pure and colourless. The refuse of the prussiate of potash manufactories will have this effect, and what remains when ivory black is digested in spirit of salt (muriatic acid) will do still better. But this kind of charcoal is neither cheap nor abundant, and therefore cannot be recommended to general use. The refuse animal charcoal of our manufactories is now sold as a manure, at the price of several pounds a ton; either those who sell or those who use it might render it still more valuable by causing fermenting liquid manure to filter through it before it is applied to the land.

But other kinds of charcoal possess this property to a certain extent. Wood charcoal reduced to powder, charred saw-dust, and charred peat, are all capable of being used with advantage in extracting the ammoniacal and other salts which give its value to the liquid of our farm-yards. Experiment has shown that, when filtered through a bed of such charcoal, the liquid escapes without colour and almost without taste, while the charred peat or saw-dust is itself converted into fertilizing manure. Wherever such charcoal, therefore, can be obtained in abundance and at little cost by the practical farmer, this mode of employing it may be both useful and profitable to him. Saw-dust or peat may also be mixed with earth and charred, when the heap, after being several times drenched with liquid manure, will be converted into a valuable compost.

Still it will be uncertain that the liquid thus treated has been deprived of all the fertilizing substances it contains. Even when it passes off perfectly transparent, colourless, and without smell, it often, indeed almost always, contains in solution both organic and inorganic substances, which are useful to the plant. That it contains soluble organic matter is shewn by its again becoming muddy, and fermenting, when allowed to stand for a considerable time, while the inorganic or saline substances are readily detected by evaporating the clear liquid to dryness.

However beneficial, therefore, the use of such forms of charcoal may be, we can scarcely consider it, in almost any circumstances, as likely to effect a saving of the whole of the

valuable matters contained in our liquid manure. A great portion of the loss now incurred may be prevented by the use of such kinds of charcoal, and the fertilizing substances may, through their means, be applied to our crops, at seasons of the year for which, in the liquid form, they are not suited—still the application of the whole liquid to the land would return to the soil more of what the crops had carried off, and would thus keep it longer in a state of fertility without the aid of foreign manures.

Various other substances have been recommended and used for the purpose of extracting from the liquid of the farm-yards, from urine, and from the water of our common sewers, the different chemical compounds they are known to hold in solution. Thus, burned and powdered gypsum, when intimately mixed with such liquids, falls for the most part to the bottom, carrying with it a greater or less proportion of the matters which the water had previously dissolved. This powder, when collected and dried, forms the principal part of what is known in the manure-market under the name of *urate*, and is more or less valuable according to circumstances. But it always leaves in the liquid much more than it extracts from it, and hence goes but a little way in saving what the liquid manures contain.

Again, if alum or sulphate of magnesia, (Epsom salts,) or sulphate of zinc, or sulphate of iron, (green vitriol,) be mixed with fermenting urine or tank-stuff, a powdery matter, more or less dense, will fall to the bottom, which will contain the phosphates and a portion of the other saline and even of the organic constituents of the liquid. This powder, therefore, may be used as a manure, either alone, or, what is better, in admixture with other fermenting manure; but all these substances leave most of the valuable salts in the water behind them, and, therefore, besides their cost, are open to the objection that they do not perform the purpose for which they have been employed.

This latter objection applies more strongly to slaked lime, which does indeed carry down much of what the liquid holds in suspension and in solution, such as the phosphates and much of the organic matter, but it leaves behind all the ammonia, and even decomposes the ammonia-producing substances which those liquids contain, and causes their elements to be more speedily dispersed through the air.

On the whole, therefore, it does not appear that at present we are likely to obtain any means of *completely*, *easily*, and *cheaply* separating the fertilizing ingredients of our tank-stuff from the water in which they are dissolved. It is not likely, indeed, that any generally available means will be soon discovered by which these fertilizing substances can be wholly extracted in a dry form equal in manuring value to the liquids themselves as they flow from our farm-yards.

The method of absorbing the whole liquid by partially dried peat, and thus adding to the quantity of fermented manure at the disposal of the farmer, is perhaps a better, as it is certainly an easier way, of using up the liquid manure where peat abounds, than the method of using charred peat to separate its constituents. This method is very extensively employed both in Ireland and in Scotland, the only objection being, that the manure is not so portable as that which may be obtained by the use of peat in a half charred state. The use of peat, indeed, in our dung-heaps cannot be too generally recommended. It prevents the escape of ammoniacal and other volatile substances, it absorbs disagreeable odours, and renders the neighbourhood of dunghills less unpleasant and unwholesome. It is probably owing to the copious use of peat in this way that so little injury arises to the health of the peasantry of Ireland and of parts of Scotland, from the dung-pit so often seen before the doors or beneath the windows of their cottages.

XIII.—OF THE COMPOSITION OF BARLEY, AND OF THE DIFFERENCE BETWEEN POT AND MALTING BARLEY.

A few months ago my attention was drawn, by Mr Johnston of Bathgate, a most zealous member of our Association, to a curious circumstance in regard to barley, with which I had been previously unacquainted. He stated to me that there were certain fields in his neighbourhood which were noted for producing barley which answered well for being converted into pot-barley, while the barley from other fields adjoining them could not be economically used for this purpose. He supposed the difference to be owing to some chemical difference in the composition of the two varieties, connected probably with the nature of the soil, or with the kind of manure applied to it, and he asked me to explain to him in what this difference consisted.

As I was unacquainted with the peculiar qualities which fitted this grain for the purposes of the pot-barley manufacturer, I consulted a gentleman of long experience in the barley trade and in malting, and I obtained from him the opinion that the best barley for malting was also the best for making pot-barley. The plumpest grain, he said, usually malted best, and the roundest and plumpest grain was also subject to least waste when manufactured by the miller into the common *pot* or into *pearl* barley. This answer satisfied me that the point put to me by Mr Johnston, and which was new to myself, was also not generally known or understood even by persons otherwise skilful and experienced in the general qualities of barley. In stating, therefore, to Mr Johnston the result of my inquiries, I asked him to supply me with further information upon the subject; and, if he conveniently could, to send me a sample of each of the varieties which in his neighbour-

hood were considered best adapted respectively for malting and for making into pot-barley. In reply I obtained from Mr Johnston the following letter:—

BATHGATE, 16th *August* 1845.

DEAR SIR,—I had the honour to receive your valuable communication of 8th ultimo, for which I beg to thank you. I was also favoured with your subsequent note regarding the statement I made in the letter I addressed to you, as to the greater or less plumpness of different samples of barley for the manufacture of pot-barley and for malting. The person you mention as having spoken to respecting the difference, I have no doubt is well acquainted with the barley market; but it is possible the difference referred to may not have come under his notice. The roundest and plumpest grain may in *general* be the best for malting, as well as for making pot-barley; but from the information I have through two persons of much experience in their respective lines, the one a distiller, the other a maker of pot-barley, I am convinced that of two samples of equal weight, the one starchy and the other flinty, the former will be found particularly valuable for malting, but not at all suited, from its soft texture, for making pot-barley—the latter, on the other hand, may both malt well and be profitably used for making pot-barley. In order to shew this difference, I beg to hand you two specimens of pot-barley made from different samples, both originally of the same weight, viz., 54 lbs. per bushel. No. 1, made out of the starchy good malting variety, you will observe is much rounded off on the ends and otherwise run down in the process of milling, many of the grains, as if of a softer quality than the generality, being reduced to less than a-half of the regular size, and ground in some cases into forms approaching to square. The grains of No. 2, on the contrary, are much more equal in size, the process of manufacture having acted uniformly on the mass.

As I mentioned formerly, the barley grown on the farm from which No. 1 is taken is much prized by the distillers; on the other hand, that grown on the farm producing No. 2, is liked for making pot-barley, and, according *to the report of the barley miller, is worth* 1s. *or* 1s. 6d. *per quarter more than the other, at the same weight, for his purpose.* I am not quite so sure as to the distiller's estimate of No. 2, but believe it to malt well. I may mention that both the samples are Scotch grown, of the variety commonly called English, (not Chevallier,) and that No. 1 sample has been grown on the same farm year after year, without being changed for twenty years or more. The miller informs me he occasionally falls in with samples of the same soft or starchy quality grown in other localities, where the seed has been changed. He says he thinks something may be due to the seed, but more to the nature of the soil as a cause.

I have no doubt that the difference referred to has been observed by practical men elsewhere than here, though no notice appears hitherto to have been taken of the somewhat curious fact. I have no doubt you will interest yourself in discovering the cause, and I shall be much gratified to know the result of your investigations, having no doubt of your discovering it. The only conjecture I can form is, that the starchy quality of No. 1 may arise from the want, in the soil, of a sufficiency of nourishment furnishing nitrogen—and this I am led to infer from the circumstance that little manure, except what was made on the farm growing that sample, was ever added to it for many years, notwithstanding it was regularly cropped, and the grain, hay, and dairy produce carried to market. I am not inclined to attribute the difference in any degree to the variety of seed.—I am, &c.

JOHN JOHNSTON.

To Prof. JOHNSTON, Edinburgh.

The above interesting letter shews that the apparent difference between the two qualities of barley is, that the one is soft and starchy while the other is hard and flinty. It is well known that different samples of wheat exhibit similar differences in quality, and that the miller usually requires to mix a quantity of foreign flinty wheat; or of the harder varieties grown in the chalk districts

of the south, with his home-grown grain, before he can grind it with advantage.

As to the cause of this flinty character, and its probable connexion with the proportion of nitrogen in the seed, or of manure containing nitrogen in the soil, the conjecture of Mr Johnston is one which might naturally arise in the mind of a person who has studied the subject with so much interest as he has done. It is said, for example, that hard flinty wheat gives a wheaten flour which takes up more water than that made from softer kinds of grain; and as there is an impression that the power of absorbing water is in some measure proportional to the quantity of gluten which flour contains, it would seem to be probable that the quantity of water absorbed might conversely be assumed as an index of the proportion of gluten contained in a given sample of flour.

And yet there are certain known circumstances which might lead us to doubt whether a flinty sample of grain could be supposed, merely on account of its flintiness, to contain more gluten, and, therefore, more nitrogen. For instance, rice is one of the hardest varieties of grain we know, and yet it is one of those among our cultivated grains which, so far as it has been analysed, is least rich in nitrogen. This fact might lead us to suppose that the hardness of a sample of grain is a proof that it contains less nitrogen instead of more.

Thus, in the absence of analyses, nothing can really be safely conjectured as yet, in regard to the composition of a sample of grain from its hardness or softness compared with others. I was, therefore, very much pleased to have the opportunity of testing the supposition of Mr Johnston by submitting the two samples of pot-barley he had sent me to a comparative analysis. I instructed my first assistant, Mr Fromberg, to make an accurate determination of the per-centage of water and of nitrogen they respectively contained. This he has done with the following results:—

	Water, Per ct.	Nitrogen Per cent.		This Nitrogen is equal to Gluten and Albumen. Per cent	
		Undried.	Dried.	Undried,	Dried.
Soft Barley, . .	13 55	1.21	1.52	8 24	9.53
Flinty Barley, .	13.11	1.21	1.39	7 61	8 76

It thus appears

1°. That the flinty barley contains a very little less water, or, in other words, is a little drier than the soft barley. This we might probably have anticipated.

2°. That the flinty variety contains less nitrogen than the soft variety. The conjecture of Mr Johnston, therefore, is not borne out by the analysis. The difference, however, is small, and *has probably nothing whatever to do with the degree of hardness or softness of the sample.*

I think it very likely that the flintiness which our varieties of grain exhibit, under certain conditions of soil, climate, manure, tillage, &c., is dependant upon other causes than the proportion of nitrogen or gluten they respectively contain. It indicates, I think, merely a peculiar condition, chemical or physical, of the starch which the grain contains, though what conditions are necessary to the production of this state of the starch I am unable as yet to explain.

I have been told that certain qualities of barley are also preferred for grinding into barley-meal. I should be obliged to any of our members who would inform me what these qualities are, and how far they coincide with those which render barley valuable to the maltster or to the manufacturer of pot-barley.

XIII.—OF THE USE OF BARLEY-STEEP WATER AS A MANURE.

It is well known to makers of malt, whether for the purposes of brewing or of distilling, that the water in which barley is steeped, preparatory to its being made to sprout, extracts a considerable quantity of matter from the grain, and often becomes very dark in colour. The water in which the grain is steeped is changed once or twice, and when drawn off is allowed to run to waste. My attention having been drawn to this point by some members of the Association, I obtained from a maltster in Edinburgh a portion of the water of the first steeping, in the state in which it is usually run off into the drain, in order that, by sub mitting it to analysis, I might be able to answer a question put to me by some of my correspondents—Is this water capable of any useful application as a manure?

When evaporated to dryness, this steep-water left a solid resi due, amounting from an imperial gallon to 413.6 grains. On analysing this solid matter it was found to consist of—

	In a gallon.	In 100 of the solid matter.
Organic Matter, Gum, Sugar, Portein Compounds, &c.,	166.40	40.23
Alkalis and Alkaline Sulphates, and Chlorides,	198.84	48.07
Phosphoric Acid in the state of Alkaline Phosphates,	8.52	2.06
Phosphates of Lime and Magnesia,	23.20	5.61
Carbonate of Lime,	15.36	3.48
Loss,	1.28	0.55
	413.6	100.00

It thus appears that this steep-water contains much valuable matter of a kind likely to promote the growth of plants. The

organic matter is capable of supplying organic food—the inorganic matter, alkaline salts, and phosphates—in a state in which they can readily make their way into the roots of plants. It ought not, therefore, to be allowed to run to waste wherever convenience exists for readily applying it to the land.

By referring to a preceding article on the composition of liquid manure, it will be seen that this barley-steep water holds in solution nearly as much solid matter, on the whole, as some of the liquid manures of our farm-yards do, and more phosphates than these sometimes contain. If so much, therefore, can be justly said of the value and of the importance of saving these liquid manures, we may with equal justice recommend that the steep-water in question should not be allowed to run to waste.

It will be understood that the preceding analysis can shew only the *kind* of substances which this steep-water is likely to contain. The *proportion* will vary with the sample of grain, with the purity of the water perhaps, and with the length of time during which the barley has been steeped. It may be stronger or weaker than the water analysed in my laboratory, and, therefore, more or less valuable as a manure. The first steep-water is likely to be the strongest and most valuable.

The above analysis was made in the spring of the present year, and since that time Mr Houston of Johnston Castle, one of our members, and who is always ready to test any new suggestion, has had an opportunity of applying it to a crop of young corn—oats, I believe—and, as he has informed me, with very marked advantage. I would strongly recommend that in the ensuing season others should try its effects both upon corn and upon grass.

XIV.—OF THE USE OF SOUR BEER AS A MANURE.

In connexion with the composition of the steep-water above analysed, it is interesting to consider that of the beer, which is afterwards prepared from the malt—though, of course, the constituents of a gallon of beer will vary very much with the kind and strength of the liquor. A variety of strong ale sent for analysis by a member of the Association was found—

1°. When evaporated to dryness, to leave, from an imperial gallon, $7\frac{1}{4}$ ounces of dry solid matter.

2°. When burned, this dry matter left 5.43 per cent. of ash, or about 170 grains from a gallon. By far the largest portion of the dry residue, therefore, consisted of gum, sugar, and other organic matter, and it is curious to observe that the quantity of inorganic matter left by a gallon of this strong ale was actually

less by one-third than was left by a gallon of the steep-water. Thus, a gallon of the

	Organic		Inorganic.
Steep Water left	166.4 grs.	and	247 grs.
Strong Ale, —	330.0 —	—	170 —

During the process of steeping, therefore, before it is malted, the barley appears to part with the largest portion of the soluble saline substances it contains.

3°. The inorganic matter of the ale, when analysed, was found to consist of—

	In a Gallon.	In 100 of the Ash.
Phosphate of Magnesia, . . .	53.1 grs.	31.32
Sulphate of Lime, ...	21 8	12.83
Alkaline Salts, soluble in water, .	86.6	50.57
Insoluble Siliceous Matter, . .	9.0	5.28
	169.5 grs.	100.0

This analysis shews that we have the alkaline salts here as in the steep-water, but that the earthy phosphate present was phosphate of magnesia. These substances, as well as the organic matter, are all fitted to feed the growing plant, and, therefore, when beer *becomes sour* in large quantities, it may be of use when applied as a liquid manure. It will increase our estimation of the steep-water, however, to recollect that it is richer even than strong ale in those inorganic substances which form one of the kinds of food without which our present races of plants cannot live.

XV.—OF THE WASTE LIQUOR OF THE POTATO MILLS.

Along with the waste liquor from the steeping of barley I may briefly notice that of the potato mills now so extensively in operation in various parts of the country. The first washings of the pulp of the potato, or the water in which the potatoes are grated, is very rich in saline matter, and in substances (protein compounds) capable of yielding nitrogen to the growing plant. These latter substances are also of a nutritive quality, and the liquor, though it gradually assumes a very dark apparently unwholesome appearance, may yet, in some cases, be found valuable as a drink for pigs and cattle.

At all events, however black it may become, this liquor is capable of useful application as a manure. Being derived from the potato, one would naturally suppose that it would especially promote the growth of the potato crop. This idea was tested in the neighbourhood of a potato mill in Perthshire, on the potato crop of 1843. The liquor was run into the drills, and potatoes were afterwards planted in these drills without any other manure.

The crop came up well, and Mr Binning Home of Argaty informs me that it was equal to that of the other parts of the field to which the ordinary manuring had been applied.

It may not be convenient in some localities to apply it in this manner to the potato crop, but it may in very many cases be employed to water or irrigate the grass and other herbage to which liquid manures are usually applied.

This liquid varies, of course, in fertilizing value according to the quantity of water with which the proper juice of the potato may have been diluted. The solid matter which remains when this liquid is evaporated to dryness has been analysed in my laboratory, and there is no doubt whatever of its fertilizing qualities; but I delay the publication of the numerical results until the variations in its composition have been determined by a more numerous series of comparative analyses.

XVI.—OF THE PER-CENTAGE OF LIME IN DIFFERENT SLATE-ROCKS.

Soils are formed either from the rocks on which they rest or from rocks which are to be found usually at no very great distance from the spots where the soils themselves are observed. The presence of lime in considerable quantity is almost essential to the fertility of a soil in our climate. When a particular rock prevails, therefore, over a large extent of country, it is not only interesting in itself, but it is important in reference to the improvement of the district, to know what proportion of lime the rock usually contains. If the rock contains little, the soil formed from it must contain little, and, therefore, will require large and continued additions of this substance to bring it into, and maintain it in, a fertile condition.

The slate-rocks which stretch across the whole of Scotland, from St Abb's Head to the Mull of Galloway, are of great interest in connexion with these views. They form a large extent of surface; and the soils under cultivation over this surface are seen in many places to be directly formed, or to be actually forming, by the crumbling of the rock. Moreover, much of the country, though improvable, is still in a state of nature, and the application of lime is one of the surest means by which this improvement is to be effected. It is, obviously, therefore, of interest to know what quantity of lime the rocks naturally contain, and which they can yield to the soil as their particles crumble down.

There is also another circumstance which gives an interest to this inquiry. In some parts of this slate country beds of marl occur in the hollows and at the bottoms of bogs, which marl was employed in former times for laying upon the land. There are few or no known beds of limestone in the country, whence then

had the lime been derived, the gradual deposition of which had produced these beds of marl? Was it derived from the general slate-rocks of the country? Then these rocks must not only contain lime, but they must contain more in some parts than in others, since these beds of marl are only found in the hollows of particular parts of the country.

During an excursion through the southern portion of this slate country, I collected a number of specimens from different beds of the rock, and at different places, chiefly within the counties of Wigton and Kirkcudbright. These I gave to my pupil, Mr Norton, with a request that he would determine the proportions of lime they respectively contained. Many of them were traversed by white hair-like streaks of carbonate of lime, and nearly all of them exhibited a slight effervescence when treated with acid, shewing that they contained traces of lime in the state of carbonate. The results of the analyses of seven varieties were as follows:—

	1.	2.	3.	4.	5.	6.	7.
Lime in state of Carbonate, per cent.	7.19	0.26	1.98	0.25	0.22	...	0.19
Lime in state of Silicate, ...	0.24	0.62	0.30	1.09	0.43	0.50	..
Total Lime per cent., ...	7.43	0.88	2.28	1.34	0.65	0.50	0.19

The proportion of lime, therefore, in the different beds of this formation is small. In general, therefore, the soils formed from them will be deficient in lime; and hence the reason why in practice it has been found that the addition of lime is an almost necessary preliminary to any successful and permanent improvement of the surface where *these* soils prevail.

At the sametime, it will be seen by the composition of No. 1 that some beds contain what may be called a large quantity of lime, and will therefore form soils that are of a richer character. The waters also that percolate through them, or the springs that rise from among them, will contain a considerable quantity of lime, and they may both sweeten the natural herbage, and, when they collect in lakes and marshy places, may yield lime enough to admit of the gradual deposition of beds of marl.

The old red sandstone slates also vary in the proportion of lime they contain. Such a slate, from the Fotheringham estate, in Forfarshire, gave Mr Norton—

Lime in the state of *Carbonate*, ...	0.39 per ct.
Do. do. *Silicate*, ...	0.87
Total Lime, . . .	1.09 per ct.

The known fertility of certain soils belonging to the old red sandstone formation does not depend merely on the proportion of lime they contain; yet, in the less fertile parts of this formation, the per-centage of lime contained in the rocks exercises a

material influence on the agricultural capability of the soils which rest upon or are formed from them.

XVII.—OF THE COMPOSITION OF THE LIME REFUSE OF THE BLEACHERS, AND ITS USE AS A MANURE.

In the spring of the present year, when the turnip season was approaching, Sir John Ogilvie, another zealous member of our Association, sent to me a portion of the lime refuse of a bleachfield in his neighbourhood, with a request that I should cause it to be analysed, and give him an opinion as to its agricultural value. It was lying at the bleachfield in large waste heaps, and could be had for a merely nominal price. Upon analysis, my assistant, Mr Fromberg, found it, after drying, to consist of—

Organic Matter and a little Water,	18.57
Sulphate of Soda and Sulphuret of Sodium,	14.23
Oxides of Iron and Alumina,	5.07
Carbonate of Lime,	55 18
Siliceous Matter,	6.60
	99.65

Considering the large proportion of alkaline matter as well as lime it contained, I recommended its use in preparing the land for a green crop, or as a top-dressing for grass and especially for clover—in most cases, however, to be used only in the state of compost.

The owners of the works, considering that the large quantity of alkaline matter found was more than their refuse ought to contain, forwarded another sample for analysis, in which about 8 per cent. only was found. The first benefit of my analysis, therefore, was in this case derived by the manufacturer. He discovered that, from an oversight of his workmen, he had hitherto been throwing away what was valuable, and he therefore took measures to have his refuse washed more free from alkaline matter in future. This, indeed, is generally the first result of the analysis of manufacturing refuse, with a view to agricultural purposes, *where such analysis is communicated to the manufacturer*. He finds that some substance which adds materially to its value as a manure can be turned to more profit by himself in another way; he therefore varies his process in order to save this substance, and thus renders his waste of less value to the farmer. This is, no doubt, an economical result, which it is very desirable to attain and encourage, but it is evidently not the interest of the farmer to be at the expense of such analyses for the primary benefit of the manufacturer.

Yet though more carefully washed, this refuse is fitted to be of

much use, and may be tried by such farmers as are not so far off as to make the carting too expensive. In proof of this, and to shew the way in which it has been used, I annex an extract of a letter I lately received from Ireland, containing an account of its application to the turnip crop:—

INGRAM FARM, NEAR LISBURN, IRELAND,
4th August 1845.

My employer, Mr Richardson, is a very extensive linen manufacturer and bleacher, and for some time past has occasionally been in the habit of applying the lime-waste of the works as manure. This year (before I came here) it was applied liberally to Swedish turnips, along with a little night soil. The soil is rather a stiff clay, not what we should consider in Scotland a *likely* soil for turnips, but has been thorough drained. For a considerable time, indeed until a week ago, the limed turnips were decidedly the worst in the field. The weather had been very dry, but since then we have had a plentiful supply of rain, and I now find that, in another day or so, they will be equal to the best, and have every appearance of being a very great crop. I may mention that, when thinning them out previous to the rains, such plants as were pushed out by the hoe, shewed an immense number of fibres, (much more than the turnips on the dunged part,) and all grasping a lump of the waste lime, evidently shewing that the plants were sucking and deriving nourishment from it, although, from the effects of the drought, they could not be so much benefited as if it had been showery weather.

Besides waste lime, there is a considerable quantity of waste leys daily run off into the Laggan; these have not been as yet saved, but I intend getting it done, and making it up into a compost with earth.

I am about to make trial of muriate of lime, as a means of fixing the ammonia of stables and dung-hills. It is manufactured by a firm in England, and delivered in Liverpool at 45s. per ton. From the experiments which have been made with it, it appears to answer the purpose remarkably well, and is of great use in mixing with guano. It appears that it is made by a soda manufacturer, who, finding great complaints made against the injurious effects of the muriatic acid escaping by his chimneys, has contrived a chamber containing lime in a continual state of moisture, and into which the gas is conducted, instead of being, as formerly, carried up the chimney.

R. OLIPHANT PRINGLE,
Land-Steward.

This letter will probably draw the attention of farmers in the neighbourhood of bleach-fields to the possibility of using this waste lime with advantage and economy.

XVIII.—OF THE COMPOSITION OF OIL-CAKES.

The *exact* composition of oil-cakes being hitherto little understood, I took the opportunity afforded me by the receipt of several samples for examination, to cause them to be rigorously analysed, both in regard to their organic and to their inorganic parts. This analysis was performed by various methods, which I need not detail, and by several of my assistants. The analyses of the ash and the combustion for the purpose of determining the nitrogen, (or protein compounds,) were performed by Mr Fromberg—other parts of the examination were made by Mr Thomas.

1°. *Composition of the organic part* of two varieties of linseed-

cake and of one of gold of pleasure cake. These were found to consist respectively of—

	English Gold of Pleasure.	English Linseed Cake.	American Linseed Cake.
Water, ...	9.95	10.05	10.07
Mucilage, ...	35.08	39.10	36.25
Albumen and Gluten, . . .	25.50	22.14	22.26
Oil, ...	12.42	11.93	12.38
Husk, ...	10.16	9.53	12.69
Saline Matter (Ash) and Sand,	6.89	7.25	6.35
	100.	100.	100.

These analyses are interesting in several respects. They shew—

a. That the per-centage of the protein compounds, here called gluten and albumen, is nearly equal to what is contained in pease and beans, and that, therefore, for the production of milk for the cheese-dairy, and for laying on muscle, oil-cakes are as valuable as beans, pease, or clovers. This is a result somewhat unexpected, inasmuch as the value of oil-cakes in the feeding of stock has hitherto been supposed to depend very much upon their power of laying on fat: in other words, upon the per-centage of oil they contain.

b. The proportion of oil remaining in these cakes is greater than is naturally present in any species of grain or pulse usually cultivated as food for animals. Oats contain as a maximum about 7, and Indian corn about 9 per cent. of oil, but these cakes contain 12 per cent., and are, therefore, in their ability to supply fat to an animal, superior to any of our cultivated grains.

c. All the three cakes resemble each other in their general composition, and, no doubt, differences exist between different samples of the same cake equal to those which the above table exhibits, between the several samples of different kinds of cake. This is especially interesting in reference to the gold of pleasure cake recently introduced into the English market, which has a peculiar flavour, but is said to be relished by cattle, and which, according to the analysis, possesses feeding properties equal to those of the best English and American linseed cakes.*

It is difficult to say, as yet, in what form the protein compounds exist in these oil-cakes. That a portion of them is in the state

* I may here notice an analysis of the seed of gold of pleasure published by the patentee for making oil-cake from this seed, and purporting to be made by Dr Ryan. This analysis states the nitrogen in the seed at 12.27 per cent., equal to 77 per cent. of albumen, &c., and after the expression of the oil, the cake should contain upwards of 80 per cent. There is reason to think that the alleged result of Dr Ryan involves a large error.

of *soluble albumen* is shewn by rubbing the powdered cake in a mortar with successive portions of cold water, filtering, and then heating the dilute solution nearly to boiling, a portion of albumen coagulates, falls to the bottom, and may be collected. By boiling the insoluble residue in acetic acid, a portion of coagulated albumen is dissolved, and may also be collected by neutralizing the acid solution. Mr Thomas obtained in this way, from the three cakes in one trial, the following quantities of albumen—

	Soluble.	Coagulated.	Total.
English Linseed Cake, ...	3 69	3.08	6.77
American, ...	3 30	2.88	6.18
Gold of Pleasure, ...	3 75	2.92	6.67

The albumen thus obtained did not amount to more than about one-fourth of the weight of the protein compounds present in the cake. The rest must be in the state of casein, gluten, &c., or, perhaps, in that of a compound peculiar to these oily seeds. These compounds, however, must all be modified in the cake by the heat which is applied to the seed during the process of extracting the oil.

2°. *Composition of the ash or inorganic part* of the several kinds of cake.

These analyses were conducted by Mr Fromberg in the ordinary way, and I only insert their results. The ash consisted of—

	English Gold of Pleasure.	English Linseed Cake	American Linseed Cake.
Alkaline Salts, ...	30.43	31.55	38 20
Phosphates of Lime & Magnesia,	40.56	47 67	56.26
Lime, ...	3 46	4 88	1.24
Magnesia, ...	0.49	1.51	trace
Silica, ...	13.65	10.81	4.04
Sand, ...	10.84	3.86	—
	99.43	100.28	99.74

Upon these analyses the following observations present themselves.

a. The ash of these oily seeds—in so far as we can judge of it from that of the cakes, which are seldom manufactured from perfectly clean seed—resembles that left by our grain-crops, in containing a large proportion of phosphates. In the gold of pleasure cake this proportion appears less than in the others, but this arises in part from its containing 11 per cent of sand and nearly 14 per cent. of silica, a portion of which may, in reality, have been derived from the sand which the cake contained, and which is very difficult to estimate exactly. The same may be said of the silica in the English linseed cake, and, in

fact, the pure lint and gold of pleasure cakes must be analysed from different localities before we can determine what proportion of silica the pure cakes *ought* to contain.

In the above analyses the proportion of magnesia in the state of phosphate was not determined, nor the phosphoric acid in the alkaline salts; the exact proportion of this acid contained in the ash cannot, therefore, be deduced from these analyses. We may safely estimate it, however, at one-third of the whole weight of the ash. In the ash left by our usually cultivated crops of grain, when free from husk, the phosphoric acid forms about one-half of the whole weight. A knowledge of these several proportions suggests the following very interesting practical observations:—

1°. These oil-cakes leave six per cent. of ash, of which one-third consists of phosphoric acid: 100 lbs. of oil-cake, therefore, contain 2 lbs. of phosphoric acid. On the other hand, our common kinds of corn—wheat, for example—leave only two per cent. of ash, of which one-half consists of phosphoric acid, or 100 lbs. of wheat contain 1 lb. of phosphoric acid. *Therefore*, for laying on *bone*, or for supplying the materials of bone to growing stock, *oil-cake is twice as valuable as wheat*, weight for weight, and *more than twice as valuable as oats or barley* which are covered with a husk.

2°. Again, the same reasoning shews us that, as grains of all kinds draw their phosphoric acid from the soil, these oily seeds will exhaust the soil of its phosphates to a much greater degree than our corn crops: 100 lbs. of linseed will carry off twice as much of them from the soil as 100 lbs. of wheat.

3°. But the same circumstance supplies us with an additional reason why the manure of *full-grown* store stock fed upon oil-cake is so much richer than that obtained by the use of any other kind of food. It is richer—

a. Because, as we have above seen, the proportion of the protein compounds (albumen, &c.) in the oil-cake is greater than the fattening animal can appropriate, and thus much of them passes off in a more or less changed state and is mixed with the dung.

b. The oil also is in larger proportion than can at times be laid on their bodies even by fattening stock, and this unquestionably contributes to the fertilizing quality of the manure.

c. But the full-grown animal appropriates scarcely any of the *phosphates*—the whole of these, therefore, which the animal consumes in its food, appears again in its dung. And, as we have above seen, the oil-cakes being richer in these phosphates, weight for weight, than any kind of corn we use for food, the dung thus made is also richer in these phosphates than that

which is obtained from animals fed upon almost any other kind of food.

I do not at present advert to other points of interest, to which the above analyses will naturally draw the attention of the intelligent farmer—such, for example, as the supposed exhausting nature of the flax crop, and the alleged economy of using lint *seed* in the feeding of cattle. These and other points I shall have occasion in subsequent articles to take into detailed consideration.

XIX.—CAN A SUBSTITUTE BE RECOMMENDED FOR OIL-CAKE IN THE FEEDING OF CATTLE?

This is a question which is interesting in many points of view, though I cannot yet fully answer it. It implies two things—*first*, can a compound of other kinds of food be made up which shall be as good for feeding cattle, and form as rich a manure, as oil-cake? and, *second*, can this mixture be sold at a cheaper rate than oil-cake? We may be able to fulfil the first condition—but, unless the mixture is cheaper than oil-cake, we can scarcely hope to supply its place to the farmer— we can never expect to supersede it.

When the Committee of the Agricultural Chemistry Association did me the honour, at the beginning of this year, to submit this question to my consideration, the chemical composition of oil-cake was unknown; and, therefore, there were not the means of determining how it would be possible to fulfil the first condition—to make a mixture which should be equally capable of all the useful applications which are now made of the natural oil-cake. It was chiefly with the view of supplying the data by which this practical question was to be resolved that I caused the oil-cakes, which form the subject of the preceding article, to be subjected to analysis in the laboratory. The results of the analyses above stated shew upon what circumstances the peculiarly valuable qualities of oil-cake depend, and enable us to say how far we can hope successfully to imitate it. Let us briefly consider these circumstances.

1°. The oil-cake contains from 22 to 25 per cent. of protein compounds, (albumen, gluten, &c.) In this respect the pea and the bean are the only seeds that approach to it—the pea containing about 24, and the bean sometimes as much as 28 per cent. of such protein compounds. The bean, therefore, is the only other vegetable food we possess which can be made the basis of an artificial imitation of the cake from oily seeds.

2°. The next peculiarity in the oil-cakes is the large proportion of fatty matter they still contain. In the best English and foreign cakes, the unextracted oil appears to amount to nearly

12 per cent. This also is greater than any other food usually given to our cattle contains. Oil or fat, in some cheap form or other, must, therefore, be added to any mixture which is to rival oil-cake. If, with 90 lbs. of beans, we could mix, grind up, or otherwise incorporate 80 lbs. of oil or fat, we should have a compound nearly equal, in all but one respect, to an equal weight of the cake from the natural seed. Thus 100 lbs. of English oil-cake and 100 lbs. of beans, so prepared, would consist respectively of—

	Linseed Cake	Prepared Beans.
Starch, Sugar, and Gum or Mucilage, ...	39	40
Gluten, Albumen, &c., ...	22	25
Fat, ...	12	12
Ash, ...	7	3
Water* and Husk, ...	20	20
	100	100

On comparing these two columns, we see that the mixed beans have the advantage in regard to starch and gluten, and are defective only as regards the inorganic matter or ash. Of this last the beans contain only one-half, and will, consequently, be deficient in alkaline matter and in phosphates, as compared with the oil-cakes.

The difference in composition between the ash of the bean and that of the oily seeds, so far as they have hitherto been analysed, does not appear to be very great, the main difference being that the beans contain more alkaline matter and the oily seeds more lime. An addition of 6 lbs. of ordinary *bone-meal*, recently ground, and in a fresh and sweet state, would supply the lack of lime and phosphates, and would make a mixture equivalent in chemical composition, and, therefore, I should hope, equal in fattening and other virtues, to an equal weight of oil-cake.

First Prescription.—Thus the proposed mixture would consist of—

Bean-meal, ...	90 lbs.
Oil or Fat, ...	10
Bone-meal, ...	6 lbs.
	106 lbs.

These would require to be mixed, ground, or boiled up together, and might be given as food either in a dry or a wet state. Or they may be made into a cake—which would keep for any length of time, by drenching the mixed powder with a weak solution of glue, (made by boiling bones in water,) and then compressing the whole into a mould.

The principle of this mixture being known, other modifications

* The proportion of this water would vary in different samples of beans.

of the above may be devised, but if formed of vegetable food, the bean or some other kind of pulse must form the basis of them all. The proper proportioning of the fat to the protein compounds is a matter of vital moment. In the relative proportions of these two classes of substances consists the main distinction between the bean and the oily seeds. The small quantity of oil it contains forms one of the chief reasons why the bean, though known to be valuable in feeding, when given in limited quantity, yet cannot be given with safety in very large proportion to the greater number of our domestic animals.

Second Prescription.—The principal difficulty attending the above prescription will be in procuring and mixing the fat with the bean-meal. But the same end may be attained in a different way. Fresh linseed, of good quality, contains upwards of 20 per cent. of oil. A mixture, therefore, of

Bruised Linseed, ...	40 lbs.
Bean-meal, ...	60
Bone-meal, ...	4

would contain of the several constituents which are essential to the value of the mixture *about*

Starch, ...	40 lbs.
Protein Compounds, . .	27
Fat, ...	11
Saline Matter, ...	7
Water and Husk, . . .	15
	100

This mixture approaches very nearly in composition to the original oil-cake. There seems, therefore, a very good *theoretical* reason for the practice now strongly recommended by many persons, of using a mixture of bruised linseed, or of linseed jelly, along with the other food given in the ordinary feeding of stock. The oil and saline matter of the linseed actually makes the starch and protein compounds of the rest of the food go farther.

I suppose it would be a very simple process, by the aid of a gentle heat, to compress into hard, durable, and tenacious cakes, the above mixture of linseed, crushed beans, and bone-meal.

Third Prescription.—But there is a third method of making a mixture of this kind. I do not pronounce with the same degree of confidence upon the following prescription, however, chiefly because our knowledge is still defective upon some points involved in it, but I insert it for the consideration of those who are interested in this matter, and for the purpose of its being submitted to experiment by any of our members.

I have already said that it is the protein compounds—those yielding nitrogen to the animal—which are especially abundant in the oil-cakes, and, therefore, difficult to supply in equal proportion, except by the use of a very limited number of vegetable substances. But there is an animal substance which might be obtained in comparatively large quantity, from which a compound capable of supplying nitrogen to the animal might be artificially made up with comparative ease. This substance is *gelatine* or *glue*. By boiling bones this is readily extracted, and by concentrating the solution and mixing with it the other ingredients of oil-cake, in a dry state, a compound or cake might be formed, which would probably feed well, and might be preserved for any length of time. With this gelatine we could mix the meal of any grain, or starch of any kind, selecting that which was cheapest and most easily obtained. The glue of commerce contains a variable quantity of water—sometimes not less than a third of its whole weight—were we to employ such glue, we might take in round numbers—

30 lbs.	Glue equal to . .	dry Gelatine,	20 lbs.
72 ...	Barley-meal equal to	Gelatine,	6 ..
		Starch,	40 ...
		Fat,	3 ...
10 ...	of Oil or Fat, ...		10 ...
112 lbs.			

so that 1 cwt. of this mixture would, with the addition of 6 lbs. of bone-meal, be equivalent to 100 lbs. of oil-cake.

But the manufacturers of such an article as this would not use the glue of commerce; they would prepare their own jelly by boiling bones, and would save labour and fuel by adding the starch and fat during the concentration of their glue. The bones would also yield a certain quantity of oil, and would thus render it unnecessary to add so large a proportion of this necessary ingredient.

I have said that our knowledge is at present deficient upon some of the points which are involved in the supposed efficacy of the above admixture, and that I am by no means so confident in recommending the manufacture and use of this as of the other mixtures to the practical farmer. The point of uncertainty is this. The gelatine contains a larger proportion of nitrogen even than albumen or the other compounds of protein, and, therefore, may *possibly* be capable of nourishing the animal even more than these substances. But its true effect, when introduced into the stomach of animals, has not yet been fully established. It is not certainly known, for example, that the

gelatine will *readily* form the substance of muscle, because, before doing so, it must undergo a certain chemical change, which the digestive apparatus of the healthy animal may not be able, comfortably and with ease to itself, to effect. This, however, is only a supposition, supported by certain experiments made in unnatural conditions, and, therefore, by no means conclusive. From numerous considerations, I think it likely that such a mixture as the above will resemble oil-cake, in its feeding and other properties, and, therefore, I recommend it as worthy of a trial.

The *mechanical* question—how such mixtures could be most perfectly and cheaply made; and the *economical* question—as to the relative cost of these several mixtures, and of the oil-cakes they are intended to supersede, I delay at present to enter upon. Indeed every practical man can easily inquire into and answer these questions for himself.

REPORT on the IMPLEMENTS and MACHINES EXHIBITED at the HIGHLAND and AGRICULTURAL SOCIETY'S GENERAL SHOW, Held at DUMFRIES in 1845.

By Mr JAMES SLIGHT, Engineer, Curator of the Society's Models and Machines.

It is not without a feeling of diffidence and a strong sense of the onerous nature of the duty which the Directors of the Highland and Agricultural Society have, in this matter, confided to the author of this report, that he now comes before the society and the public, and particularly those individuals more directly interested—the exhibitors at the show. The Directors, by defining the duties and objects connected with this report, have, by so doing, rendered these duties, though not less onerous, at least more agreeable and easy of accomplishment. As for the objects of the report, it may be proper in the outset to state the leading points which the Directors have in view. From the great number of exhibitors, and the comparatively small number of premiums which could be offered, and seeing that, of necessity, some of the unsuccessful competitors would exhibit articles which, in quality, might fall but little short of those for which premiums would be awarded, the Directors justly considered that all parties might be benefited by the publication of a judicious report of the whole exhibition. Besides adverting, in such a report, to what might be found commendable in all deserving cases, it was in the instructions of the Directors to point out striking defects of construction or of principle, wherever such should occur; and the object of this was, that such criticisms might serve not only

as a corrective to those machinists whose works exhibit defects, but be useful as cautions to those who are more fortunate or better instructed. To render the report more intelligible, it has been thought advisable to insert the specification of the premium for each class of articles.

Relying on the indulgence of the Directors, and on that of the individuals whose works are to be noticed, for any omission or even mis-statement that may possibly occur, arising from the various other duties to which the reporter had to attend during the days of the show, he humbly proceeds to discharge the duties intrusted to him, which, to the extent that his limited space allows, he will endeavour to do with all fairness and impartiality.

Class I.

For the best collection of Agricultural Implements and Machines of any Description, manufactured by or under the superintendence of the exhibitor, just proportion of parts, workmanship, utility, and price being considered. Premium, Ten Sovereigns.

In this class only one exhibitor appeared, R. Gray & Sons, Uddingstone. The collection comprised 9 implements, viz. —3 ploughs, 1 subsoil-plough, 1 cart, 2 drill or subsoil pulverizers, 1 set draught-bars, 1 drill-plough; and of these implements, eight of them competed also in other classes, the remaining one, therefore, falls only to be particularized under this head, viz.—

A set of two-horse draught-bars for equalizing the draught. This article exhibited no novelty, the construction being nothing more than the well-known shifting shakle, (or fulcrum,) which, by lengthening one arm of the lever, (the main bar,) and shortening the other, gives the means of accommodating the naturally unequal power of a heavy and a light horse when yoked in the plough or harrow as a pair.

As a collection, R. Gray & Sons' implements, though not numerous, exhibited in almost every case a highly commendable example of *workmanship*. Defects there were in some points in the proportioning of parts, and there were also errors in construction, to be afterwards noticed; but, as a whole, the collection does much credit to the firm of Gray & Sons, as well as to the school in which the head of that firm originally obtained the rudiments of his mechanical education, the workshops of Wilkie of Uddingstone. There being no competition in this class, together with the reasons indicated above, the judges felt not warranted in giving the full premium offered, but awarded 5 sovereigns to Messrs Gray & Sons.

Class II.

For any new and useful Agricultural Implement or Machine, that has been satisfactorily tested in actual work, not previously exhibited in competition—a Premium of Five Sovereigns.

In this class there were ten entries, embracing 15 articles, most of which deserved notice.

Richard Colman of Colchester, Sussex, exhibited his patent expanding lever-harrows, in two sizes, his own invention, price £7 : 10s. and £8 : 10s. These harrows embody two essential points—1*st*, The principle of their expansion, which is based on a strictly geometrical principle—that a parallelogram, divided into any number of lesser parallelograms, by lines drawn parallel to two of its contiguous sides, will have these smaller, each exactly similar to the original figure; and whatever degree of obliquity may be given to the greater, each of the lesser will undergo the same change, preserving the exact similarity of figure. 2*d*, The harrows being supported on small wheels attached to levers, whereby any degree in depth of penetration by the tines is readily obtained at pleasure, by changing the position of the levers.

The first property is an important one as applied to the harrow, and the changeable nature of the parallelogram when not tied by a diagonal, as well as the constant similarity of its integral divisions, are very beautifully brought to bear in this improvement. By their means this harrow is capable not only of making every tine form a distinct line in the soil, like the best kinds of common harrow, but the distance between the whole of these lines can be varied with mathematical exactness, both as to equality one with another and to extent of variation. Thus, they will draw lines that shall be all four inches, or all one inch apart, or at any fractional part of the distance between these; and the construction being effected, the changes are produced by simply changing the place of a hook in a chain. We have few examples in agricultural machinery where a geometrical principle has been so happily applied, and applied too to one of the rudest of implements. The variation in depth of penetration seems also a considerable step in the perfecting of this harrow, that being a point in which all others are defective. An objection was made to the use of cast-iron in these harrows, but the inventor stated that he also makes them entirely of malleable iron. As there was no opportunity of testing these harrows in the field, it would be premature to pronounce upon their *practical* efficiency, though in principle they are in advance of all others. Under the circumstance also of these harrows being

patented, the judges, though approving, could not do more than award to Mr Colman a premium of 3 sovereigns.

Alexander Dean, Birmingham, entered his universal crusher for linseed, oats, beans, barley, pease, malt, &c., and his gorse or whin-crushing machine, but the former only came forward, and that not till after the judges had reported. It could not, therefore, compete, but is an article deserving notice here. This crushing machine is of an improved construction. The two rollers are each 18 inches long and 7 inches diameter; they are grooved in the longitudinal direction, with an obliquity of about 5°. The grooves are pitched at 8 in the inch, very shallow, and the ridge flattened on the top. This last quality admits of scrapers being applied to the rollers; hence they cannot become clogged, though the grain or seeds should be damp. The rollers revolve in opposite directions, the one making three revolutions for one of the other. The adjustment of the rollers is accomplished in a more perfect manner than usual, by a worm or screw-wheel fixed on each of the adjusting screws, and these are acted upon by a spindle carrying a worm or endless screw at each end. By these means the adjusting screws act always together, preventing the possibility of placing the rollers in closer contact at one end than the other. This method of adjustment is not new in itself, but has hitherto been applied to machinery of a higher order. This machine is altogether fitted up in a style superior to the ordinary construction of agricultural machinery, and does credit to Mr Deans, while it may also stand as an example for further attention, and care being bestowed upon this hitherto rather neglected branch of mechanism.

Robert Elliot, Hardgrave, Dumfriesshire, exhibited a hand stubble-rake, the invention of H. Smith & Co. of Stamford, price £2. This instrument is mounted on wheels, and furnished with a discharging lever. It appears much too fragile for its purpose, and while it is greatly inferior to the common horse-rake in construction and efficiency, its price is little inferior.

John Geddes, Cargen Bridge, Kirkcudbright, exhibited a drill-sowing machine for grain, recommended as requiring no toothed wheels to regulate the discharge of the seed—price £12. The judges awarded to Mr Geddes the premium of 5 sovereigns for the ingenuity displayed in the construction of this machine.

In this drill-sowing machine, which is a modification of the English lever drill, there is, as usual in all Mr Geddes' productions, a very considerable display of ingenuity and contrivance. In some points these are to the furtherance of the objects of the machine, in others they form defects. Thus, in the discharging apparatus, we have a reciprocating action for the discharge of the seed by means of a lengthened plate perforated and recipro-

cating over corresponding perforations in a fixed plate, the motion being produced by a circular revolving ratchet acting on one arm of a lever, the other being attached to the end of the slide. This is a very ingenious combination, but is inferior in point of simplicity, and is more liable to derangement than either the spoon wheels of the English drill, or the yet more simple, though perfectly effective, method of the Scotch broad-cast machine, by small toothed wheels, and which has been with complete success adapted both to the common and lever Scotch drills. The seed tubes which, in the English drill, are usually a series of tinplate funnels, are here formed of small trunks of thin deal, with two knee-joints in each, which allow the coulters to rise and fall, and at the same time afford on opportunity for the sower to see that the delivery is going regularly on. The principle of these tubes is good, but the material is somewhat objectionable. The coulters are arranged to sow at 6 inches apart, a distance that destroys one essential object of sowing grain in drill—that of cleaning the ground between the rows, and it appears by almost universal consent that 9 inches is the approved distance. Mr Geddes has very judiciously placed the coulters alternately in advance, which, in this close practice, will prevent their choking, an inconvenience that would certainly occur were they placed in one line in such near proximity. This machine is the first of its peculiar construction, and has been but little tried in the field, but its main features coincide with one that has been some years in successful use.

Two implements, by R. Gray & Sons, Uddingstone, Lanarkshire, whose object is similar, namely, the tillage between the rows of green-drilled crop, and are named subsoil pulverizers—these implements fall under the class of horse-hoes, but are of stronger construction than usual. Their object is to penetrate into and stir the subsoil between the rows of potatoes, turnips, &c.

James Kirkwood, Tranent, East Lothian, exhibited a revolving harrow for breaking and pulverizing land. This implement is held to be of considerable importance—it has been lately introduced from Norway, and first adopted on the Duke of Buccleuch's home-farm, Dalkeith Park; and Mr Kirkwood, with his usual alacrity, has made some improvments on the original. The implement is essentially a clod-breaker, lighter and cheaper than those made under Crosskill's patent, but will not be altogether so effective. It consists of an oblong frame of iron, mounted on four low wheels. Two axles pass across the frame, and on them are strung a number of star-like cast-iron spoke-wheels, each with 4, or in some cases 5, pointed arms or rays, about 7 or 8 inches long—they stand about 5 inches apart, while the

axles are *twice* or more the length of the rays from each other, and the star wheels are so arranged on the one axle as to fall intermediately with those of the other, thus producing a more uniform effect on the soil. This appears to be the original form of the machine, but Mr Kirkwood has added two or more grubber tines fixed in the same frame. A trial was made of this implement in the trial field, but the soil being of a light free texture, not at all adapted to the objects of the Norwegian harrow, its effects could not be appreciated. From the known importance of the implement, and being the first in this country to take up its manufacture, the judges awarded to Mr Kirkwood a premium of 3 sovereigns.

Norman Lockhart of Tarbrax, Lanarkshire, exhibited also a very excellent example of the Norwegian clod-breaker, made also after the original model, by Richard Stratten, Bristol. In principle and general construction it differed so little from the former as not to require further remark. The judges awarded to Mr Lockhart, for the introduction of this implement, 2 sovereigns.

A very handsomely finished five-fold ribbing grubber or plough was exhibited by Hugh Cowan, Corstorphine, Edinburgh. This implement has the general appearance of a grubber, but, in place of the simple tines, it is fitted with five small double mould-board-plough bodies. The arrangement of this implement is not new, the society having, on a former occasion, awarded a premium for a similar ribbing machine, but constructed of wood. The judges, therefore, though much pleased with the construction and finish of Mr Cowan's machine, could not do more than express their approbation, though aware also that it is giving every satisfaction in practice. The price of the implement is £5.

An unpretending, cheap, and simple mode of ventilating corn and hay stacks, was produced by Robert M'Turk of Hastings-hall, Dumfriesshire, and made by Robert Watt, Dumfries. The invention consists in forming skeleton cylinders, with very slight laths of wood, fixed upon iron hoops of about 8 inches in diameter. They may be made to any length, and are easily joined end to end, or turned in any direction within the stack, forming permanent air tunnels through it. For this invention the silver medal was awarded to Mr M'Turk.

Class III.

For any Design, Model, or Drawing of any new Machine or Implement.—The Gold or Silver Medal.

In this class the only objects of importance were a series of models from William Crosskill, Beverly, Yorkshire.

1*st*, Models of patent wheels and axles, in the making of which every known appliance of mechanical aid is adopted, to secure correctness of construction and expedition, with uniformity and neatness of finish.

2*d*, Improved cart, with self-acting tail-board or door, for discharging the contents of the loaded cart—a very ingenious contrivance, adapted to coup or tilt carts, in which the act of unlocking and tilting also opens the tail-board; but it seems to be one of those inventions that are in advance of their times, hence its adoption by farmers, in the present state of farm-machinery in Scotland, is doubtful.

3*d*, A one-horse cart, after the Scotch model, without anything remarkable except its very handsome finish.

4*th*, Iron liquid-manure cart. This is a model of a very complete and efficient machine. The distributer is believed to be particularly so—consisting of a trough with a serrated edge, over which is placed a sluice-board or plate, adjustable to any quantity of discharge.

5*th*, Read's patent subsoil pulverizer, made by Mr Crosskill. This instrument, like others of its kind, is, properly speaking, a furrow-grubber, intended to follow a common plough in the manner of subsoil-ploughing; but it differs from others of the same kind in being supported on four wheels. For this model the silver medal was awarded to Mr Crosskill.

Class IV.

For such useful Improvement in the Construction of the Subsoil-Plough as may be best suited to accomplish the main object of subsoil ploughing, viz.—moving, breaking, stirring, and effectually detaching the subsoil from its own substratum, without bringing it to the surface—the Premium of Seven Sovereigns.

In this class three exhibitors appeared, and a fourth entered in Class XII.

1*st*, By James Anderson, Howwood, Renfrewshire, and made by Andrew Carnduff, Howwood. This is one of those implements styled subsoil pulverizers, or furrow grubbers, having three swan-neck grubber tines only, in place of the share and feathers of the true subsoil-plough; and, as usual, it follows in the furrow of a common plough.

2*d*, By R. Gray & Sons, Uddingstone, a Smith's subsoil-plough, with proposed improvements. These consisted principally in the arrangement of the feathers or cutters; thus, in place of the usual sock feather a crescent-shaped cutter is attached to the body behind the sock. This cutter seems judiciously placed, but is misshapen, one-half nearly of its apparently cutting edge looking backward, as if placed for ornament rather than use. The usual ver-

tical cutter is, in like manner, out of shape, its proper duty being to cut that part of the subsoil into which the plough penetrates, seldom exceeding 8 inches, it is not requirod to rise higher than that; but in this improvement the feather rises in an obtuse arched form, to 12 or 14 inches. The implement in all other respects shewed a fine example of workmanship and judicious construction to secure strength. As an example of the latter, the two body bars were welded up solid with the beam.

In this class, during the trials, appeared also the two furrow-grubbers of Messrs Gray, and likewise a mole-plough convertible into a proper subsoil-plough, from John West, Lundie, Forfarshire.

In the trials of these implements in the field, it was observed that James Anderson's plough, drawn by two horses, penetrated to a depth of 9 inches below the sole of the preceding common plough furrow with a draught of 36 stone. The effect was the stirring up and mixing a portion of the subsoil with the upper soil, approaching to the effect of trenching, and the implement worked very satisfactorily.

Messrs Gray's subsoil plough was observed to work very heavily, and performed, in the opinion of the judges, less satisfactorily than those of the usual form of the Deanston plough. The furrow grubber or pulverizer of Messrs Gray, with three tines, indicated a draught of 24 stone, but the depth of penetration was only 6 inches; and though it seemed to move tolerably steady, its effects were deemed insufficient. The five tined drill grubber or pulverizer of the same firm was found to have the tines two wide set, which, by cutting on both sides beyond the proper width of the furrow, produced a heavier draught and less perfect work than the former.

J. West's plough of Class XIV. was tried in its form of a mole-plough, when, with a depth of 8½ inches, it indicated a draught of 40 stone, and its effect at the surface was similar to that of the proper subsoil-plough, in not bringing up the subsoil. From the absence of Mr West at the time of the trials, the conversion of his plough into the subsoil form could not be effected; no trial, therefore, of it in that state could be made.

The judges, in considering this class of implements, found none deserving of the full premium, but awarded to James Anderson for his subsoil-plough or grubber a premium of 3 sovereigns, and to John West for his mole plough, that may be converted into a subsoil-plough, 3 sovereigns. This plough, although not entered as competing in this class, clearly commanded consideration along with those that were so entered, and for comparison also it became more convenient to consider it here.

It may be remarked, in reference to the entries in this class, that, of the implements tried under it, two only were strictly adapted to perform the requirements of the specification of

the premium. The others are a different variety of implements, not calculated to perform the requisites described; and here it may be proper to notice that Smith's subsoil-plough, as originally intended, effects its object without bringing the subsoil directly to the surface, which is of importance in many cases. The effects of the more recent variety of the implement, here and elsewhere styled subsoil-pulverizers, would produce deterioration in many cases, by bringing up the subsoil before being prepared for mixing with the true soil. In those cases where the subsoil is essentially of the same nature with the true, the latter will be improved by the direct mixing of a portion of the former with it; hence it should be kept in view that, while the subsoil plough may be used with safety in all cases, and with manifest advantage in almost all, the subsoil pulverizer can be used with advantage in those cases only where the subsoil is merely a continuation of the upper soil, but not in those where the subsoil is a poor moor-band.

Class V.

For any useful Improvement in the Construction of the Common Two-horse Plough, which has for its object the Lifting and Turning over the greatest quantity of the Soil in a given time, with the least resistance, and which produces at the same time a fair and efficient surface for exposure or for seed. Premium, Seven Sovereigns.

In this class eleven ploughs were entered, but after trials of those allotted for the trial field, and a careful examination of all that came forward to the show-ground, the judges found none that possessed any decided improvement either in construction or in effect. In consequence of this want of real improvement, the judges found that the proposed premium could not be awarded to any; while, from the workmanlike manner in which all were constructed, and in consideration of the cost incurred in bringing them to the Show, it was thought proper to award two sovereigns to each competitor, towards the defraying of his expenses.

The ploughs exhibited were chiefly after the Wilkie or Lanarkshire model, with less or more of variation from the original, and it is deserving of remark, that a preponderance of these variations were in the legthening of the mould-board.

Where all the implements were of excellent workmanship, and comparatively small difference in their forms, it was difficult to select for trial; but in the end, six out of the eleven were chosen. The trial-field was the same as for the subsoil ploughs, and was by no means favourable. It was an unequal lightish loam, and intersected by a broad band, in which the subsoil was

full of small boulders and gravel, coming near to the surface. such inequalities required great attention on the part of the judges to determine the average indication of the dynamometer for the draught, and, being a wheat stubble, was not calculated to show off fine ploughing. The same cause rendered impossible the preserving a standard depth of furrow, which would have made the comparisons more simple. The following table exhibits the results of the trials:—

Name.	No.	Draught per Stones Imp.	Depth of Furrow.	Breadth of Furrow.	Remarks.
			Inches	Inches	
W. Anderson, .	1	23	7	9	Lengthened Mould Board.
G. Campbell, .	2	25	7½	10	Do., Sole.
R. Crawford, .	3	22	6½	10	Common.
Gray & Sons, .	4	18	6	9	Common.
Do., . . .	–	19	6½	9	Obtuse body, not improved.
Do., . . .	–	26	7	9	Strong.
J. Kirkwood, .	5	26	8	10	East Lothian plough.
J. M'Carlie, . .	6	23	7	10	Common.

The ploughs exhibited, not only at the trial, but all in the class, were so well constructed, that it would be invidious to particularize, —some indeed were so highly finished as to appear as if in a holiday garb, and not in the usual solid plain style of finish which is alone wanted in all such articles. The makers, in all the examples, nevertheless, deserve the highest commendation for their exertions; and, from the number and workmanship here exhibited, it may very reasonably be inferred that the country is in no want of able artisans in this important branch of agricultural machinery.

Class VI.

For any useful Improvement in the Construction of Barn Fanners —a Premium of Five Sovereigns.

In this class two competitors only appeared. David Craig, Stewarton, Ayrshire, and Richard Wilson, Dumfries. The first exhibited a very fair example of fanners, but without anything new in their construction. A small fly-wheel is added, but this has been often tried before without establishing any permanent character. The second example is the ordinary warehouse blower or dusting fan, commonly used in granaries, being destitute of riddles, and having only one sieve. In the present case the feeding is effected by the common fluted roller in place of the shoe. No premium awarded.

CLASS VII.

For any useful Improvement in Farm-Carts and Wheels—a Premium of Five Sovereigns.

This class produced four examples of carts and wheels, all of excellent workmanship, doing great credit to the makers.

1. Robert Crawford exhibited a tilt or coup cart with a double lock, but in other respects differing little from an ordinary construction, except in finish. The side standards bolted on outside of the bed frame. The upper head bar laid flat ways and arched, bolted down to shelmonds, and finished with iron cross-head behind, the lock folding, double slotted, and keyed. Price £13. He also exhibited a dormant-bodied cart, finished in similar style. Price £12 : 12s.

2. Robert Gray & Sons, a coup-cart, also of excellent workmanship, finished very much in the style of the last, and having a proposed improvement in the formation of the axle. In this, the head or arm of the axle, instead of being turned conical, is flattened a little on three sides, so that, resting in the bush of the wheel, there are three lines of contact—one directly below, on which the load is borne, one before, which resists the force of traction, and one behind, ready to act in opposition to the last—these three lines are steeled and tempered. Except in the higher degree of finish, this is no new improvement, but a practice of very old date, originating probably in the want of means to produce a *turned* conical finish; this form was at one time held, and even now, with some artisans, is still held, indispensable to a good axle; but now that turning lathes are to be found in every considerable workshop, the method is being laid aside for the preferable, turned and tempered, conical or cylindrical arm. Price £11 : 11s.

4. Archibald Shankland, Thornhill, Dumfriesshire, exhibited a coup-cart which was also admired for the excellence of its workmanship, and though of a different construction from the former ones, had its parts judiciously arranged to produce strength. Each side was supported by three iron stays, being one more than usual; it was also furnished with a small hay frame and top sides. The locking of this cart is effected by a strong spring throwing a bar into a catch-hook on each side of the cart, a mode of locking which is becoming common, and is considered both convenient and secure. Price £10.

As a class, these four carts were perhaps the most perfect in the exhibition, and the judges awarded to Robert Crawford a premium of 3 soverigns, being especially for the double lock; and 3 sovereigns to Archibald Shankland, for the elevator and spring lock.

Class VIII.

For Improvements in the Thrashing-Machine—a Premium of Six Sovereigns.—In this class there were no entries.

Class IX.

For the most useful Improvement on the Construction of any of the Implements used in the Cultivation of the Turnip and Potato crops. Premium Five Sovereigns.

In this class 22 articles were entered by 18 exhibitors; but as many of them were implements already approved and well known, it is unnecessary to particularize such. The first to notice in the list is a turnip drill, made by John Affleck & Co., Palmerston, but invented by John Wightman, Holywood, a very compact and ingeniously constructed machine, sowing two drills at once. The frame-work of it is principally of cast-iron, as are also the seed-boxes; and the distribution of the seed is effected on the principle so generally adopted from the broad-cast machine. It has also the usual convenience of self-adjusting rollers, and the price is very moderate, £4 : 10s. The judges awarded a premium of 3 sovereigns, to be divided between the maker and inventor.

A turnip-sowing machine was exhibited by John Geddes, Cargen Bridge, Kirkcudbright, being an improvement on that for which he carried a premium at Berwick, and which appears also to have been the model for the preceding machine which has been improved by Wightman. Price £3 : 10s.

Richard Wilson, Dumfries, produced a turnip drill on the same or similar principles as the two former, but apparently got up with less care. Price £3 : 10s.

Thomas Inglis, West Linton, exhibited a double drill-paring plough, of very good workmanship, but possessing no improvement on that for which he got a premium at Edinburgh. It may be remarked that few double implements of the cultivating kind seem to obtain favour in Scottish farming; nevertheless several of them appeared on this occasion.

William Smith, Lochthorn, Dumfries, produced a very commendable selection of implements, consisting of, 1*st*, a double-drill plough, with two sets of scufflers, price £5—2*d*, a drill grubber, on the principle of Finlayson's self-cleaning implements, having swan-neck tines *bolted* upon the frame, price £4—3*d*, a common double mould-board or drill-plough, with gauges or markers to measure off the drills, price £4—and, 4*th*, a pair of saddle or potato drill-harrows, price £1 : 10s. These implements, without any pretension to unnecessary high finish, were all very substantially made, and, of course, usefully so, which is the state in which all such exhibitions should be. As a small collection of useful

implements, the judges awarded to Mr Smith a premium of 2 sovereigns.

Of the double implements, one was shewn by John B. Stainton, Milton, near Kendal, a double or twin-plough for green-drill crop, price £9 : 10s. It consisted of a four-sided frame, jointed at each angle, and attached to and jointed by the middle of the back and front bars to the beam. To each side-bar of this frame is attached a small plough body, with share and mould-board standing right and left, the mould-boards being towards each other. To the front bar is affixed a toothed semicircle concentric with the middle joint of the bar upon the beam, and this segment being moved by a pinion and handle, the side-bars of the frame preserving their parallelism, are brought nearer to or recede from each other, as the rhomboid is made more or less oblique. The hind bar of the frame has a plain quadrant or a semicircle fixed to it, and by means of a pinching screw it is clamped to the beam, thus retaining the two plough bodies at the required distances. For the good workmanship and mechanical arrangement of this implement, the judges awarded to Mr Stainton the society's silver medal.

John West, Lundie, Forfarshire, again brought forward his potato-lifting plough, with some improvements since a former exhibition. The leading principle continues the same, being the body of a common plough, with a wheel placed at the heel, to give motion, through the medium of a pair of small bevelled wheels, to a short horizontal shaft, carrying three or four flat iron blades or hoes about 4 inches broad. These, as they revolve at right angles to the path of the plough, through the potato-drill, break down and spread the slice of earth which the body of the plough progressively raises containing the tubers. The slice being thus broken down, the tubers are exposed and more easily collected. As will very readily occur on a consideration of the motion and effect of these revolving hoes, the apparatus is very liable to choke from the entanglement of the potato haulms with the hoes; and even though the haulms have been previously cut off and removed, the liability to get choked up still remains, from the roots and fibres existing in the soil. Mr West is deserving of great commendation for his ingenious and excellent workmanship, in this as well as in other articles of his manufacture; but it were, perhaps, better for him to exercise his skill on something more promising than this mode of potato-raising.

Class X.

For the most useful Improvement in any of the Utensils or Machines used in Dairy Husbandry—a Premium of Five Sovereigns.

In this class a considerable assortment of utensils was exhibited.

1. David Craig, Stewarton, Ayrshire, a horse-churn, differing in some points, which he conceives to be of importance, from the common Lanarkshire churn, as requiring less power and less time for the performance of the operation. It does not appear that the changes in the arrangement of parts, as here introduced, can produce any marked improvement or advantage. The individual parts, and the number of these, remain nearly the same as in the old arrangement, difference in position being the principal change; but, in justice to Mr Craig, it must be observed, that the work is very well executed, and the price, £14, very moderate when the quality of workmanship and substantial construction are considered.

2. A cheese-press by Robert Crawford, Uddingstone, exhibited nothing different from ordinary lever cheese-presses, but its price, £2, is very moderate. The workmanship does not come up to Mr Crawford's usual style.

3. A curd-cutter, by Robert Miller, Balgray, Lockerby, was approved of, and the silver medal awarded. This simple machine consists of a hopper, or box, 14 inches deep, 18 inches wide at top, and 5 inches at bottom, the length being 14 inches. On one side of the box is placed two rows of 31 knives or cutters. In the one row they are 1 inch long, in the other 3½ inches. A roller or stock, 3 inches diameter, is fitted to turn in the bottom of the hopper, and is armed with three rows each of 32 cutters, placed spirally on the surface of the roller, falling intermediate with those in the hopper. The roller thus armed is turned by the hand within the hopper, with a velocity double of the hand, by means of a wheel and pinion. With this machine a quantity of curd, the produce of 30 or 40 cows, can be cut or broken in four minutes. The price is £1 : 10s.

4. Richard Robertson of Lisburn, Antrim county, Ireland, exhibited a variety of dairy utensils, chiefly churns, made by him after the registered invention of John Rowan and Sons, Ballyclare. They are on the principle of the box-churn, in which the cistern is stationary, and the plunger revolves, with examples also in which the milk or cream is surrounded by a case to contain hot or cold water, as the temperature may require. According to capacity these churns are worked either by hand or by power, and their price ranges from £2 : 5s. to £9 : 10s.

Mr Robertson's milk ripeners are vessels in the form of a deep pail, made of tinplate or other metal, and cased in the same, or in wood, forming a narrow chamber, surrounding the milk, and which is filled with water of a temperature suited to the intended expedition of the process of this artificial ripening. Price 14s. to 18s. The judges awarded 5 sovereigns for the churns, to be divided equally between the maker and inventor.

Class XI.

To the implement maker who shall have successfully introduced into Scotland, of his own manufacture, any Machine or Implement that is generally approved in the practice of agriculture in England or elsewhere, or a modification of the same, and which has hitherto been but little known or employed in Scotland. Premium Five Sovereigns.

In this class William Crosskill, Beverly, Yorkshire, exhibited his well-known clod-crusher, for which a premium was awarded at the meeting at Glasgow in 1844. Its merits are now so well known as to render description here unnecessary.

Richard Robertson, Lisburn, Ireland, exhibited a portable steaming apparatus for preparing food for cattle, horses, &c., with which the judges were so well satisfied, that the full premium of 5 sovereigns was awarded to Mr Robertson, and the silver medal to Mr Jennings, New York, as part inventor. The apparatus here exhibited is of a portable nature, in so far as it may be set down anywhere, and without brick or stone work. The boiler is of the well-known construction, long since occasionally applied, as the conical upright boiler. It consists of an outer and inner shell, the former of which may be cylindrical; the water is contained in the space between the two shells, which is closed at top and bottom, while the interior cone is open at both; the bottom with grate bars forming the furnace, and from that upward the chimney, terminating in an iron funnel, around which, and at a proper height, is fixed a cistern of water. The water becomes partially heated by the funnel passing through it, and in this state is taken into the boiler as required, in the usual way, by the feeding apparatus. The cooking vessels are placed around the boiler, and in connexion with the steam-pipe, the usual appliances of stopcocks and couplings being employed for connecting the vessels with the steam-pipe. The price varies with the extent of the apparatus from £8 to £21. For small establishments this apparatus seems very well adapted; but its advantages for those of great extent are not so obvious.

Class XII.

For a Weighing-Machine adapted to general Farm purposes. Premium Five Sovereigns.

In this class there were no entries.

Class XIII.

For any improved Tile-Pipe or other invention for securing the Run of Water in Drains, possessing the advantages of cheapness and durability, combined with efficiency. Premium Ten Sovereigns.

1. Robert Beart, of Godmanchester, Huntingdonshire, exhi-

bited in this class specimens of a mode of securing the continuity of the conduit formed in a drain with tile-pipes, by a very simple yet very effective expedient. In the ends of each tile a simple square notch or indentation is formed, not exceeding half an inch in the length and one-fourth inch in width. When the pipes are being laid in the drain, a little wooden dowel, one inch in length, is inserted into the notch of the pipe already laid, which will thus project half an inch beyond the end of the pipe. The next pipe is brought to have its notch coinciding with the dowel in the first; it is then pushed up till the projecting part of the dowel passes into its notch, which connects the two, and effectually prevents the one swerving from the line of the other. This being repeated with every tile laid, and the earth filled in, the conduit will be continuous and unobstructed. It is of no moment how soon the wood may decay, as the earth is no sooner filled in than all displacement of the pipes is prevented, although the dowel were to suffer immediate destruction.

Specimens of tiles and soles of excellent quality were exhibited by Robert Boyle, Ayr; Thomas Chalmers, Dalbettie; Thomas Thorburn, Ryedale, Kirkcudbright; and John Henry Charnock, Wakefield, Yorkshire.

Mr Smith, late of Deanston, produced an interesting specimen of drain-pipe, manufactured from peat-moss, very perfect in its fabrication, and having its ends formed upon Mr Smith's patent mode of joining drain-pipes, the tri-lobate junction. It is to be regreted that Mr Smith has not furnished further information on this interesting subject, and all that can be said at present is, that, from the appearance of the specimen, the peat must have undergone a process of milling or trituration previous to moulding into the form exhibited. From the known durability of dried peat-moss, and the degree of perfection observable in the specimen, compared with peat-tiles, made from the moss as it exists, a great inducement is held out for the adoption of such peat drain-pipes in those districts where the material is abundant, provided the article can be produced at a moderate expense, but on this point information is wanting.

Class XIV.

For approved patented articles, and articles not coming within the range of any of the foregoing classes.

John Ainslie, Alperton, Middlesex, exhibited his drain-tile machine in operation, which gave great satisfaction, and received the award of 5 sovereigns or the medium gold medal. This new patent machine is a modification of Mr Ainslie's original patent, and is remarkable for its simplicity. A pair of cast-iron cylindrical rollers take the clay from a feeding web, and by simple adhesion it passes between them into a small chamber bounded

by a die-plate, in which is cut an orifice forming an exact transverse section of the tile or pipe to be made by it. As the clay is forced into the chamber by the revolution of the rollers, it passes out continuously at a proportionate rate through the die-plate, in one or more lines of perfectly formed pipe or tile, which, from thus taking the permanent form at the instant of ejection, are perfectly solid and free of fissures. These are first received upon an endless travelling web, which carries the ejected pipe or tile along with it; the turning of the rollers gives motion to the web, and at the same time to the cutting apparatus, which is ingeniously contrived, by means of a wire travelling in an orbit, to cut off the tiles at the desired length, while the machine and the tiles continue their motion unabated. The machine is worked by hand, and three men will produce 6,000 ordinary-sized tiles in 10 hours. The price is £30.

Mr Ainslie also exhibited plans of a patented mode of constructing a drying shed or chamber, wherein, by artificial heat, he expects to be able to manufacture tiles throughout the whole year.

The Ayrshire double-acting tile machine of Boyle & Young, Ayr, was also exhibited in operation; and, from the expedition and excellence of its produce, elicited great interest. In construction it is the Tweeddale patent machine, with very important improvements by Messrs Boyle & Young. The chief improvements are its sending out continuously two lines of tiles at once, completing both, with the same degree of precision that one line is done by the original machine, and, farther, by an ingenious and simple mode of cutting by the aid of the hand without stopping any of the motions. When in full operation, this machine, with four men, produces 8,000 tiles in ten hours. Where the clay is deficient in tenacity, all the machines acting on this principle—bending the tile into shape from a flat cake—are apt to produce tiles fissured or imperfect in the back; but in the present case the tiles produced were perfect. The price is £30. From the satisfactory manner in which this machine worked, the judges awarded the medium gold medal or 5 sovereigns for the improvement.

John Henry Charnock, Wakefield, Yorkshire, exhibited in operation his economic drain-tile and pipe-machine, price £20. This machine, which is one of the best of the intermittent kind, consists of two oblong rectangular chambers, to which are fitted two square pistons, acted upon alternately by a set of cranks and wheel-work, the same cranks being also adapted to open and shut alternately a sliding cover to each chamber, and these arrangements are adjusted to act in the following manner:—When a piston is withdrawn, the cover of its chamber is at the same time withdrawn; when the feeder throws a lump of clay into the chamber, the cover is immediately shut, and as the

piston advances, the clay is ejected through the orifice of a die-plate, as in Ainslie's machine. While this is going on, the piston and cover of the adjoining chamber have been withdrawn, and a lump of clay introduced, when the same operation as in the first is repeated, and this goes on alternately. If the lump of clay in the chamber has been insufficient to eject a full-length tile, what has been protruded remains uncut till the next charge, when its ejection completes the tile. The cutting is performed by a light iron bow and wire, connected by a joint with the *horsing* apparatus, when the horse is put under the tile or pipe, and pushed forward to its shoulder, the bow is pressed down with the left hand till the wire has passed quite through the tile. By this mode of cutting, the ends of the tile have a slight curvature, which is no impediment. This machine, with three men, produces 4,000 solid and well-formed tiles in ten hours. The judges were so well satisfied with the machine, and also with its moderate price, that they awarded a premium of 3 sovereigns.

The Garnkirk Coal Company exhibited a large collection of specimens of their fire-clay manufacture, in copies of antique vases, balustrades, elegant chimney terminations, and water-pipes—the last article being the invention of Mr James Murray of that Company. The examples from the antique in this collection are deserving of high commendation; as copies and specimens of art, they are far beyond what could be imagined as the produce of a brick-field, and their handsome finish testifies that artists of no mean character are employed in their fabrication. These articles are perfectly durable, and their cheapness puts it in the power of any person of taste to place around him copies of such of those examples of ancient art as his means may command.

An instrument called an American cradle-scythe was exhibited by Thomas Hodgson, Easton, Cumberland, which we cannot pass over without pointing out the mistaken ideas under which it had been constructed. The *cradle* seemed rather intended as a fence to retain sheep than to collect corn. It extended very nearly the entire length of the scythe-blade, and is by no means a light fabric. To wield a scythe mounted as this was, would be a punishment to a strong man. It ought to be generally known that the teeth of the cradle in a corn-scythe serve no good purpose beyond 12 inches in length from the heel of the scythe-blade.

F. M'Neill & Co., Lamb's Buildings, Bunhill Row, London, exhibited specimens of their patent asphalted felt for roofing, and dry hair felt, for forming a nonconducting medium where it is desirable to retain heat, such as steam-engine boilers, agricultural steaming apparatus, and the like. The roofing felt is an article much deserving of recommendation for all temporary erections, or even for those of a more permanent character. Its lightness enables the carpenter to construct his roof with a sav-

ing of at least half the usual materials. The price of this felt is one penny per square foot. The dry hair felt is particularly well adapted for deadening sound in any situation.

Richard Robertson of Lisburn exhibited in this class a patent cart axle, invented by John Rowan and Sons, Ballyclare, Antrim. The peculiarity of this axle is, a nest of antifriction cylinders, each equal in length to the arm of the axle, and revolving on a small axle of its own, set in a ring at each end. The invention is not new, and there is reason to fear, from former experience, that it will never be found suitable in practice.

A set of the iron-trussed swing-trees of James Slight, Edinburgh, for which a medal was awarded at the meeting at Dundee, in 1843, was exhibited, price 16s.; as also his Regnier's dynamometer, which, from its extreme simplicity, is considered by many to be preferable to those of greater complication and expense. The price is £3 : 15s.

The exhibition of cart, plough, and gig harness, together with gentlemen's and ladies' riding-saddles and bridles, by John Weir, Dumfries, was remarkable for the excellence of the workmanship and moderation of price. In consideration of which the judges awarded the society's silver medal to Mr Weir.

W. and C. Young, Edinburgh, brought forward their usual exhibition of useful and ornamental iron work, consisting of a numerous assortment of gates, hurdles, and light ornamental trellis-work, &c., the whole of which were highly commended. In an especial manner the judges were pleased with their portable iron sheep-rack, and awarded for it the society's silver medal to Messrs Young.

A collection of implements from the home farm of Marmaduke C. Maxwell, Esquire of Terregles, and made by Joseph Scurrah, Crakehall, Yorkshire, was shewn in this class. It consisted of the following articles :—

A horse-rake, on Grant's patent construction.

A grubber, partaking of the construction of Wilkie's in the frame-work and elevating apparatus, and of Earl Ducie's, in having the tines armed with cast-iron points of different shapes.

A five-tined drill-grubber, of a usual construction, and a set of S harrows.

These implements have been well tested during several seasons, and been uniformly found to answer their different purposes in the most satisfactory manner; the S harrows having in particular, been found to give the fullest satisfaction.

A novelty in the shape of a very humble but useful article, in the economy of Indian humble life, a *Pawn Goondie*, or leaf blanket, presented by Dr George Buist of Bombay. The *Pawn Goondie* is a rude weather-shield used by out-of-door labourers in India, to protect them from the rain. In its primi-

tive form it is a light frame of wicker-work, covered over with leaves, and has exactly the shape of the bow half of a small boat cut off. It is worn resting on the head and shoulders, and descends below the middle. Dr Buist recommends its adoption in this country as a very cheap *over coat* for labourers, especially those whose employment is stationary, such as stone-breakers, well-sinkers, &c ; and he proposes, in place of leaves, to use oiled linen cloth, of which material the one exhibited was constructed at an expense of about 2s.

Of this show of implements it may be said generally that it presented but little of novelty or of invention, but this should be no cause of surprise in a country that holds itself already in an advanced stage towards perfection in its agricultural economy, and in which there is consequently less encouragement given by the practical agriculturist to the exercise of the inventive faculties of its agricultural machinists. The agriculturist sees no great necessity for change in the form and structure of his implements and machines, and, satisfied with existing forms, makes efforts only to procure them at the lowest possible price. The machinist, from the great competition and consequent lowness of price of the articles he manufactures, cannot do more than procure a bare subsistence from his exertions. In this state he feels not the will nor has he the means whereby to make further efforts, especially in the field of invention, which always and insensibly leads to an expenditure which the position of such a man does not warrant. Seeing thus but faint hopes of encouragement from the quarter to which he naturally looks for aid, he settles down and plods on in the old beaten track, making, if any, but feeble attempts at improvement, much less original invention. It is notorious, also, that if an agricultural machinist makes a step in the march of improvement, his invention is no sooner promulgated than it is snatched from him, not only by his neighbours, but through those very means that are held out to him as for his benefit—it is spread all over the country, the inventor deriving little or no benefit from his skill thus exerted.

Notwithstanding these untoward circumstances for the agricultural machinist, it is pleasant to observe the altered state of these shows of implements. Seven years ago, at Dumfries, the exhibition consisted of perhaps eight or ten articles in that department. At the late show there were 89 entries, embracing considerably upwards of 140 articles, most of which were deserving of commendation for excellence of workmanship, and many for judicious construction. For this branch of the society's shows, however, it has not as yet been possible to devote a sum for premiums at all corresponding to its interest and value, or sufficient to mark, in an adequate degree, the society's sense of the merits of the exhibitors. But it is hoped it may be possible to extend, in

future shows, the amount of premiums for this important branch, and to take means, in the manner now for the first time attempted, of bringing the merits of the various implements and machines still more prominently before the public.

ON THE MINES, MINERALS, AND GEOLOGY OF WEST LOTHIAN.

By CHARLES FORSYTH, Esq., Advocate.

[Premium—Twenty Sovereigns.]

IN making a geological examination of a district such as that of West Lothian, where the minerals consist exclusively of those belonging to the coal formation and of trap rocks, it is necessary, in order to obtain such information as shall be valuable in a practical and, indeed, in a purely scientific point of view, not only that a strict inquiry should be made into the nature and peculiarities of the strata and rocks of the district, according to the method usually adopted by geologists, but also that an examination and inquiry should be made into its mining operations. It is to the practical man alone that the most valuable facts are known as to the real nature of these strata; for it is to him that their peculiarities are really important, and it is he alone who possesses the means and opportunity of tracing these peculiarities, and following them out beyond a very limited extent. It is not the less true that it is the scientific observer alone who can take an extended view of the subject generally, trace out causes, draw conclusions from facts thus obtained, and enter into a strict examination of the component parts and mineralogical character of these strata. But as it is the province of the miner to make himself acquainted with certain rules usually followed in conducting mining operations, it will indeed almost invariably be found that he possesses a knowledge of important facts of the greatest value to the scientific observer.

In describing the mining operations, it has been the author's endeavour to convey such practical information as he has had it in his power to obtain, and in such detail as appeared to him of importance. In regard to the plans and drawings necessary to illustrate the subject generally, the course preferred has been to give a general geological map of the county, and separate plans of the various mining operations where it has been considered desirable to do so, on account of their extent or the peculiarities attending them.* In regard to the connexion between the soils of the district and the subjacent minerals, and their influence upon agriculture, no general rule can be stated, as this

* It is considered unnecessary to publish the sections and voluminous details of the coal measures furnished to the Society by the Author.—ED.

depends almost entirely on the varied local peculiarities of the coal strata, but more especially of the alluvial and diluvial deposits which overlie them, and as, from the peculiar nature of the trap rocks, little can be said as to the soils connected with them, from the exposed and often precipitous nature of the districts which they compose; but it may be stated generally, that, in localities where the soil is formed merely by the disintegration of the coal measures, it is almost invariably found to be unproductive.

Alluvial and Diluvial Deposits.

The great mass of the deposits which cover the coal measures of this district are composed of beds of clay, gravel, sand, &c., which contain boulders composed of minerals similar to those which occur in the district. And although these diluvial deposits have evidently been influenced by powerful currents, it does not appear that the materials of which they are composed have been transported from any considerable distance. They are found in some localities to be of great depth, in some instances occurring in the form of rounded eminences, at others in isolated mounds, as in the neighbourhood of Bathgate, where they are composed chiefly of gravel, and are called *inches;* but more generally occupying low-lying positions. Thus, on the Avon, Breich, and Almond waters, which form the boundaries of the county, beds of earthy clay and gravel are found sometimes to the depth of 50 or 60 feet. Alluvial deposits also occur, formed by the various waters in the low grounds which they traverse, and which often, as in the Breich and Almond waters, contain trunks of large trees embedded in them. The deposit of mud usually found in large estuaries, from the water of the various streams which flow into them, is found on the northern boundary of this county. There exist on the shore of the Forth, near Borrowstowness, 2,000 acres of such deposit, apparently capable of being enclosed in the manner adopted adjacent to the river Tay, whereby a tract now waste, of no value, and which is covered by every flood-tide, might be added to the productive lands of the county.

The only other substance of this nature of any importance is peat, which occurs in some localities to a considerable extent. The peat-mosses of this district are in general what are termed flow-mosses, and appear to have been formed by great forests, which seem at one time to have occupied a considerable extent of this part of Scotland. In almost all of them trees are found embedded, and the roots in many cases appear as if in the position in which the tree stood when growing, the peat having gradually increased, and covered up these roots to a considerable depth. The bones of a large kind of deer were lately found in a moss at Boghead, near Bathgate. These mosses are in some instances

of considerable depth, being in many cases from 30 to 40 feet. The bottom of them is usually composed of clay of a bluish-white colour. The mosses of this county are gradually diminishing in extent, in consequence of the large portions of them which have been brought into a state of cultivation or planted. One very important matter connected with this branch of the present subject is that of draining. In a district where coal measures occur, the use of drains is attended with many and great advantages, in consequence of the retentive nature which usually characterises the diluvial deposits which overlie them, and more especially from the very injurious effect which is produced in consequence of the water which issues from the coal strata being impregnated with iron. But although the evil be great, the remedy, if sought for, will usually be found at hand, as these coal measures themselves almost invariably contain materials well suited for counteracting these evils, when used for making drains. Thus, in many parts of West Lothian, shale is quarried to a considerable extent, for the purpose of making drains, and is well suited for that object, as it is easily worked, and is of a very durable nature, when covered up and removed from the influence of the atmosphere. Clay is also almost invariably found in such districts well suited for making drain tiles. Thus, in the neighbourhood of Bathgate, clay which is used for that purpose is found at Inchcorse, below a few feet of moss, and diluvial clay is also used about a mile north-west from Bathgate, and at Blackness, where there is an extensive brick and tile work. Clay is also generally found in coal-pits, of a nature well adapted for making bricks and tiles. Gravel from the beds of streams is also often employed in this district, and is found exceedingly well suited for carrying off water impregnated with iron.

From the peculiar position of the coal-fields of this county, occupying as they do the intermediate spaces between the two great coal-fields of Edinburgh and Glasgow, and from the irregular position in which the strata in many instances occur, it is necessarily a matter of considerable difficulty to trace out the relation which they bear to each other. The mining operations have indeed been carried on to a sufficient extent to prove that the district contains minerals which will yet afford an extensive field for enterprising individuals, but these have not been carried on to such an extent as to furnish data by which the exact relative position of the strata can be traced throughout the district generally. In addition to the journals of the pits, journals of borings in various places are given, wherever these appeared to be valuable, as pointing out the nature of the strata at the various places in which they have been made. In regard to the various beds of sandstone, shale, clay-stone, &c., of the coal formation, little requires to be said, as those of this district have few or no

peculiarities attending them, and vary so much in their extent and position, that no fixed rules can be formed as to their occurrence, or conclusions drawn from the relative positions in which they are found, as these beds, when traced to any considerable distance, are often found to pass into others of a totally different character, or to disappear altogether. This variation in the strata is found also to occur to a considerable extent in the beds of coal.

The coal formation of this district does not consist of one continuous series of beds, but of various series, more or less connected with each other. The most extensive of these is that which occupies the south-western part of the county, and consists of the Bonhar coal-field, the Crofthead or slaty-band ironstone field, and the various beds of coal found in the neighbourhood of Bathgate, Blackburn, &c. The next series is the Borrowstownness coal-field, situated on the north-western extremity. And the next consists of various basins of coal which occupy the eastern portion of the county.

Bonhar Coal-field.

The first coal-field which occurs on the western limit of the county is the Greenrig, or Polkemmet Bonhar coal-field, situated in the parish of Whitburn. This coal belongs to the Glasgow field, and comes under that class of coal which is termed Lady Anne coal. It appears to be quite detached from the rest of the coal in West Lothian. and has not been found in any other place within it. This field is kept clear by a day level, which runs to the north to near the Almond Water. The present pit, which is worked by a common or atmospheric engine of 4½-horse power, is 19 fathoms 5 feet deep. There are a number of pits which have been used at former times, varying from 14 to 19 fathoms in depth, and there is also a stair-pit by which the men enter the workings. It is worked stoop and room, the roof being too high and too brittle to admit of its being worked in the long-wall or Shropshire manner. The present working seam which is a splint, or "back-on-edge" coal of the best quality, is from 4½ to 5 feet thick, and dips north-west 1 foot in 12. There are two seams of coal below the one at present worked. These were found by Mr Geddes, when boring to the east of the pits, and were also found on the south; and there is also a seam of parrot coal, with rough coal below it, which is crossed in the day level. This field crops out at a short distance to the east of the pits. It lies between two great faults, which are usually termed dykes, one on the north of the field running south-east, which is shewn in the accompanying plan, and throws in the coal to the south; and the other on the south, coming near the south-west corner of the field. This fault runs parallel to the Polkemmet north fault or

main dyke, and cuts off the Duke of Hamilton's coal on the south and Lady Torphichen's coal on the west. There are also a number of slips or hitches down to the south, which chiefly run in directions nearly parallel to the main faults. The coal is found to rise a little before coming to these hitches, but falls again to the same amount immediately at them. There is usually bad air near these slips or hitches, but the air is not so bad near the larger faults. This arises from the edges of the fracture in small slips being somewhat open, and partly filled with black coaly and sometimes argillaceous substances, which by the miners is termed the *vise*, and which usually forms the guide or trace by which to discover whether the coal has been thrown up or down, whereas in large slips the edges or walls at the line of fracture are in much closer contact. These openings in the vises of the small slips, by which the foul air enters the workings, are sometimes from 1 to 1½ inches wide. There is clay in the under part of what the workmen call the "dogger-band" and in the bed below the coal, which would be well suited for making bricks. There is a good field of coal belonging to the Duke of Hamilton on the south-side of the Bonhar field, which is unwrought.

Shotts Coal-field.

The first coal found on the south-west extremity of the county is the Shotts coal. On the Falla Burn, a short way north from Fauldhouse village, the entrance to an ingoing eye is seen, by which the Shotts lower or stinking coal (so called from the quantity of sulphur which it contains) was worked about ten years ago. Between this place and Fauldhouse village four or five smaller seams of coal are seen cropping out on the sides of the Falla Burn, which are the lowest seams found next to the Crofthead coal, or coal of the slaty black-band series. There are a number of ingoing eyes seen on both sides of the burn at this place, but at what time those were worked is not known. The freestone rock above the lower coal is next seen, about 40 feet above which the Shotts main coal is seen, and above which the Shotts iron-stone is found. The Shotts main coal was here worked at the Smithy Haugh, about 400 yards up the burn from Fauldhouse village, about twenty years ago, having a pump worked by a water wheel for clearing the workings to the dip. The coal was worked along with the ironstone, which is in the *Following*, or soft stratum which lies immediately above the coal. Still further up this burn, there is a good freestone quarry, called Falla Hills Quarry; the stone is of a gritty nature, very similar to a bed of freestone found in some of the pits of Bonhar coal-field.

This then is the out-cropping of the Shotts coal-field, and as it is intimately connected with the coal-fields of West Lothian, it

may here be necessary to make a few remarks on it, in order to trace their connexion, and explain the particular characters of them both.

The whole Shotts minerals may be considered as lying in a basin, rising on all sides from about the place where the engine-pit from which the water is pumped is situated. It is a very extensive field, and has, for a long course of years, been worked to a very great extent. There are two seams of coal, the upper or main coal and the lower or stinking coal. The ironstone is found in balls above the coal, and is worked along with it in the *Following*. These balls are an excellent kind of ironstone, and the coal is well suited for calcining iron and for the furnace. There are three great faults in this field. The north one, which is a continuation of Bonhar south fault, runs from north-west to south-east, and is down to the north. The middle fault cuts off the Shotts field on the north. It runs in the same direction and passes about 17 fathoms south of Shotts engine-pit. The third fault runs in a similar direction and cuts off the Shotts field on the south.

Crofthead Ironstone and Coal-field.

Next in order below the Shotts minerals is a very fine field of ironstone, situated between Fauldhouse and the village of Longridge, which has lately been opened up. This field contains the Crofthead or slaty black-band ironstone, now so highly valued. On the lands of Wester Handax Wood, the slaty band was worked by the Wilsontown Iron Company, forty years ago, by mining, but the value of it was not then known, and it was supposed that it did not extend to the north side of Breich Water, whereas it has now been discovered that the greater part of the slaty black-band lies on the north side of Breich Water.

In working the seams of this ironstone it is found to occur thus:—

1*st*, Black blase, from 9 to 11 inches thick. This blase contains, in the upper part, balls of ironstone from 2 to 5 inches thick, which are called by the workmen the "*finestone*." On the bottom of this black blase there are sometimes found irregular nodular protuberances of ironstone, which are named by the workmen "*swirliemaggies*." These sometimes come from the bottom of the black blase down through the "maggie blase" and "maggie band" to the top of the "main stone" or "mid cleave," and, when they occur, considerably impede the operations of the miner.

2*d*, Below the black blase there is a lighter-coloured blase, named by the workmen the "*maggie blase*," which is 8 inches thick.

3*d*, The upper ply or "*maggie band*," as it is called, which is the upper seam of the slaty band, and is 3½ inches thick.

4*th*, The "*mid cleave*" or "*main band*," which is the principal seam, and is 7 inches thick.

5*th*, The "*bottom cleave*" or lower seam, 3 inches thick, which has from ½ an inch to 1 inch of coal adhering to the bottom of it.

These three seams of slaty band are in all, at an average, 14 inches thick.

The floor is a sort of wild coaly slate, below which there is very hard sandstone 4 feet thick.

About from 23 to 25 fathoms below the slaty band there is a bed of ironstone balls, called by the workmen "*Thomson's balls*," which lie in a bed of clay from 4 feet to 4½ feet thick, which clay is between beds of sandstone. These balls were at one time worked open-cast, by the Wilsontown Iron Company, on the south side of Breich Water, and contain the highest per-centage of iron as yet found in any stone in this neighbourhood.

On the south side of Breich Water, and in the county of Edinburgh, on the lands of Wester Handax Wood, where the slaty band was formerly worked by the Wilsontown Iron Company, the position of the minerals is well seen. There is an old day level and an air-pit, about 3 fathoms deep, and also an engine-pit, 7 fathoms deep, where the water was pumped, and ironstone raised by a high-pressure engine, the boiler of which burst in 1839, and killed five persons and severely wounded another, since which accident the minerals have not been here worked. The whole of the slaty band as yet worked in West Lothian is in tack by the Shotts Iron Company and Messrs Holdsworth of Coltness.

The Shotts Iron Company's pits are situated on the lands of Crofthead, and form the western limit at which this ironstone has as yet been worked in West Lothian. The minerals dip to the north-west 1 foot in 7, and thus these pits are also farthest to the dip. This company have at present two pits working; an engine-pit, 14 fathoms deep, worked by a condensing engine of 10-horse power, which pumps and winds; and a gin-pit. There was also another gin-pit, which is now worked out—it was the first pit opened by the Shotts Company, and had also an ingoing eye and a level.

There is also a bed of coal 11 fathoms above the ironstone; it is kept level, free, and is worked by an ingoing eye; there have also been several pits. The seam is about 2 feet thick.

Messrs Holdsworth's pits are all on the north side of the road from Fauldhouse to Breich toll. There are four pits—Eastfield pit, 23 fathoms deep, where there is a condensing engine of 26-horse power, which pumps and winds; Crofthead pit, 15 fathoms

deep, where there is a high-pressure engine of 12-horse power, which pumps and winds; Backcroft engine-pit, 14 fathoms deep, where there is a high-pressure engine of 6-horse power, which pumps and winds; and a gin-pit at Backcroft, 10 fathoms deep. There was also another pit near Crofthead pit, which is wrought out.

There are a number of hitches or slips and faults connected with the slaty band field.

The most important of these are the faults on the north and south of the Backcroft pits, of which the south one is understood to be the south fault at Bonhar, and the north fault at Shotts to the west, and a continuation of a fault which is seen at Breich Bridge, and the north fault at Longford, to the east. The only other one of much importance is known as the south fault, which runs from Bankhead on the south side of the Breich Water, and passes within a few fathoms on the south side of the Wilsontown Company's engine-pit at West Handax Wood, then within a little to the south of Turrviews, and between the Knows and Badalan, and on the south of Leadloch. This is understood to be the fault which runs through the centre of the Shotts field. It will be observed that the general direction of these faults is from north-west to south-east, that is, nearly in the direction of the dip and rise which is the general line of the faults throughout the whole of this district. There are also a number of smaller slips and hitches of minor importance, in general running in a similar direction, but some of them rather more inclined to the north. There is also a small slip at Greenburn, which is not within the limits of the plan of the workings by the Shotts Company—it is seen in the burn, and was also found in the coal level. It will be observed that none of these faults are dykes, properly so called, although usually so termed by the miners. The only real dyke in this neighbourhood is found running through the limestone quarry at Levenseat, in the county of Edinburgh; the limestone beds being quite regular in their position on each side of it. It runs in the same direction with the faults already mentioned. Where the ironstone is worked in the long-wall manner, a subsiding takes place of about 18 inches. Great care is required in regulating the air courses, and numerous air-pits are sometimes required in consequence of the great quantity of sulphureous vapour exhaled from the ironstone, and which sometimes issues in such quantity as to be troublesome, but it is only a suffocating, not an inflammable vapour.

The ironstone is removed on railways a short distance from the pits, where it is piled in large heaps, for the purpose of being calcined. These heaps vary in extent according as it is found most

convenient, and usually contain from a few hundred to two thousand tons of ironstone. At the Messrs Holdsworth's pits, on the bottom course and along the sides, the ironstone is broken into small fragments. The Shotts Company put a few coals on the lower course, which merely causes it to burn a little more rapidly, and it is for this purpose alone that the coal is worked at Crofthead. Previously to being set on fire the heap is carefully covered with engine-ashes, in order to exclude the air, otherwise the ironstone, where exposed, becomes oxidated, and assumes a brick-red colour. 100 tons of ironstone are, when calcined, reduced to 64 tons, and when well calcined it assumes an open and foliated appearance; when it has a solid and compact appearance, it is said to have got too much of the fire. The quantity of iron got from the raw stone is estimated by the Shotts Company at 42 per cent. This iron is, in consequence of its open texture, used for mixing with other kinds of iron when put in the furnace, in order to make them flow more easily. Whilst the ironstone is being calcined, the smoke has a very stifling effect, in consequence of the large quantity of sulphureous vapour given out along with it. Sulphur is found deposited on the top of the mass in large quantities, particularly where shale is burned along with it. On a mass of shale at Wester Handax Wood, which has burned for more than a year, but without decreasing in bulk, there is found about 4 or 5 inches of sulphur. It is thought that this mineral may yet be turned to valuable account in consequence of the large quantity of sulphur which it contains. The sulphureous vapour arising from the calcining of the ironstone has a most devastating effect upon the vegetation around, the ground in some places near the pits being totally devoid of vegetation. On the lands of Crofthead, a young plantation has been totally destroyed. When the water was pumped from the workings at Wester Handax Wood in June 1840, after having been in them for some time, it killed the fish in the Breich Water and in the Almond, into which it flows.

About from 45 to 48 fathoms below the bed of clay, ironstone balls, called Thomson's balls, which is called the "curly ironstone," is found. It is a bed of ironstone balls from 2 feet to 2½ feet thick, lying below a mixture of sandstone and clay, the floor being composed of a bastard limestone from 1 foot to 16 inches thick. This ironstone is worked by the Shotts Company near Muldron, in the county of Edinburgh. 16 fathoms below this ironstone there is a bed of limestone, apparently belonging to the Levenseat limestone series, which lies below it. Below this the Wilsontown, Woodmuir, and Longford coals occur. This district, in which the slaty band occurs,

lies between the Levenseat limestone and the Drumgrey coal, which is mentioned by Mr Craig in his survey of the lower ward of Lanarkshire. There appears to be a great mass of sandstone between the slaty band series and the Levenseat limestone, as was found in a bore made on the east side of the road between Longridge and Whitburn. Whether this slaty band series extends much beyond the district in which it is at present worked is a somewhat doubtful point. Mr Craig states that it is found at Langside, in the parish of Shotts, and it is said to have been found south from Cult in the lands belonging to Sir William Baillie at Heads-farm, in the same neighbourhood, that is, about a mile and a-half north from Crofthead.

Boarbachlaw Coal.

The highest field of coal at the western extremity of the county connected with the Bathgate series of coal is the Boarbachlaw coal, which dips to the north by east. There was an old working south-west from the present working pits, where there were a number of faults. There are two seams of coal within these faults, the lower one of which is all worked out by a day level, the upper seam, which is unwrought, is 2 feet thick, above which there is a seam of ironstone 4 inches thick, which is capable of being worked along with the coal. The present working pits are outside of these dykes, they consist of an engine-pit, 9 fathoms deep, from which the water is pumped by an atmospheric engine of 10-horse power, and a working pit 16½ fathoms deep, where there is a gin for winding, which is worked by one horse.

Boarbachlaw Mill and Bathville Coals.

Below the Boarbachlaw coal there is a bed of coal called Boarbachlaw Mill coal, which was worked near Boarbachlaw Mill 23 years ago by a day level. It is rough coal, and dips in the same direction as Boarbachlaw coal. There is a black slate above it, and then fire-clay and grey blase, above which there is a bed of freestone, which formed the roof of the workings. Coal was also at one time worked at Bathville, south-east from Boarbachlaw Mill, where there were two pits, an engine-pit and a working pit. This is supposed to be the same bed as Boarbachlaw Mill coal, as they dip in the same direction, and as there is a bed of black slate above Bathville coal similar to that which occurs at Boarbachlaw Mill.

Colinshiel Coal.

The next in order after Boarbachlaw Mill and Bathville coal is the Colinshiel coal. At Colinshiel colliery a bed of coal is

worked exactly similar to Boarbachlaw coal, and is understood to be the same seam. It dips north-east scarcely 1 foot in 12. There are a few slips in Colinshiel coal-field running in the direction of the dip, none of which exceed 6 inches. There are 2 pits, an engine-pit, 12 fathoms deep, at which there is an atmospheric engine of 16-horse power, which pumps the water, and a working-pit, 13 fathoms deep, where there is a gin for winding, worked by one horse.

Colinburn Coal.

The next in order is the Colinburn coal, which lies 12 fathoms below the working seam of Colinshiel colliery. This intermediate space contains various seams of coal and ironstone. There is a fault on the south side of the Colinburn field, which runs from south-west to north-east, and which appears to be a continuation of a branch dyke or fault which runs from Boarbachlaw east fault, a little to the north of the Edinburgh and Glasgow road, and which was found in an old pit at Boarbachlaw; and at the east side of the mill it appears to be thrown down at least 40 fathoms. This coal was at one time worked north from Armadale, where there were a number of pits. In the bed of the Colinburn, about 400 yards north from Armadale, near some of the old pits, Colinburn coal is seen cropping out, lying under shale and ironstone bands. It is an excellent coal, a mixture of rough and splint coal, and is considered to be very like Bonhar coal; it dips 60 degrees north-east 1 foot in 3, and is capable of being worked along with the ironstone in the long-wall manner, the clay iron-band being excellent, and there being a rock roof. A good section of the strata lying below this coal is seen on the side of Boarbachlaw Burn near Boarbachlaw farm-house.

About 200 yards north-east from Killycantie, a thin seam of coal and good bands of ironstone were formerly worked, and at Byemuir, opposite Killycantie, ironstone in excellent balls, some of which are about a ton and a-half in weight, were worked by the Carron Iron Company in open-cast, and by mining under a bed of freestone 12 feet thick, above which there is a bed of clay containing clay-band ironstone. These ironstone balls are 11 fathoms below Colinburn coal. On the side of Boarbachlaw Burn, a little above this ironstone mine, a pit was sunk 16 fathoms deep to a bed of coal 5 feet thick, which lies 28 fathoms below Colinburn coal. The quantity of water in this pit was so great that it prevented the workings from being continued.

Bridgecastle and Bridgehouse Coal.

North from Colinburn, coal has been worked at Bridgecastle and Bridgehouse. It dips north-east the same as Colinburn coal,

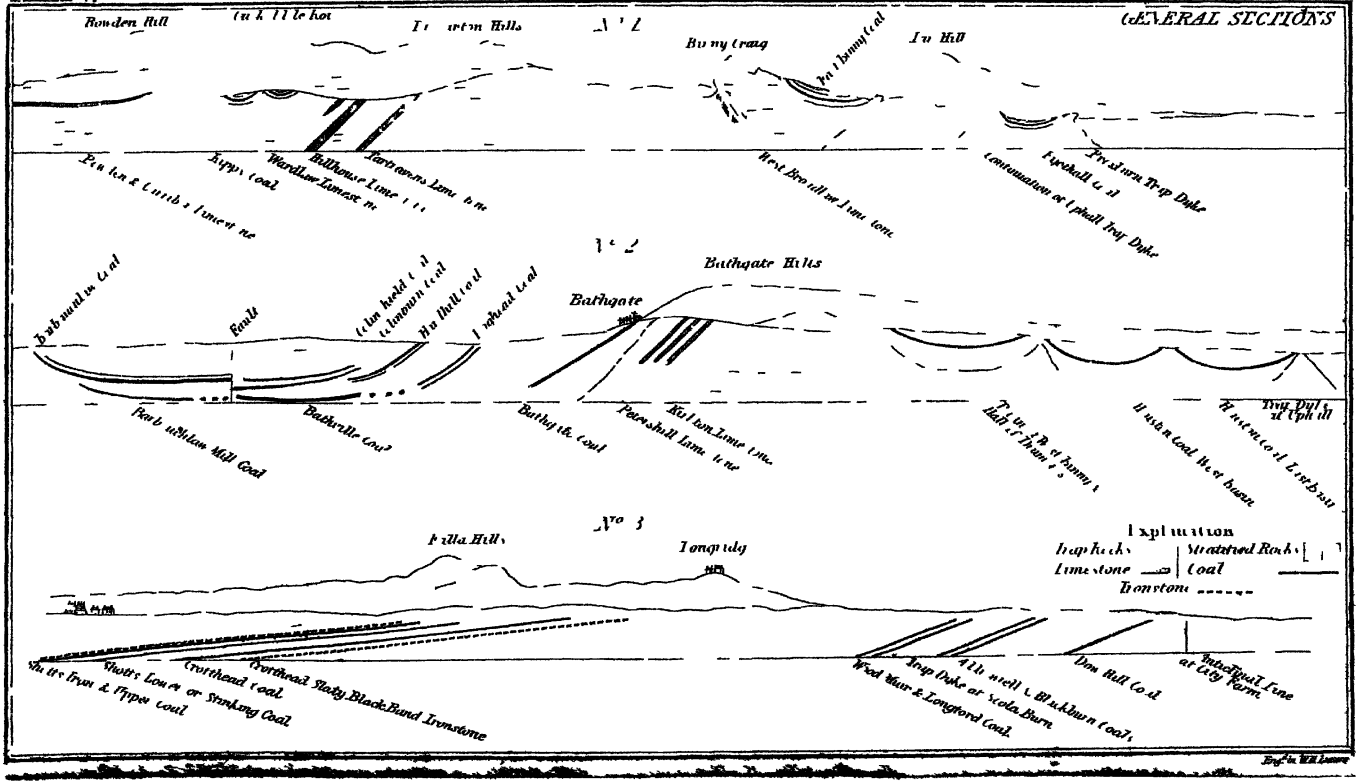
and is supposed to belong to the same bed; it is also a splint and rough coal, and is from 21 inches to 3 feet thick. There appears to be a fault on the north-east side of Colinshiel engine-pit, between the pit and the ironstone mine near Killycantie, as the ironstone balls which were worked in that mine are not seen to the south, being thrown down. This fault cuts off the Bridgehouse coal before it reaches Colinburn. There are two pits at Bridgecastle, an engine-pit, where there is an atmospheric engine of 20-horse power, and a working pit. A short way east from Bridgecastle pits, the same bed of coal has been worked at Bridgehouse, where there is a high-pressure engine of 20-horse power.

There is a trap dyke which runs to the north-east, on the north-east side of the Bridgehouse coal-field, all the coal on the north side of which dyke is blind coal. It has been worked in the lands of Crawhill and Wallhouse, which is the same seam. It is seen at different places on the Avon Water, but it is all blind coal. Blind coal has also been found at the Woolmill on Boarbachlaw Water; it is on the north side of the whin dyke. There is also a whin dyke which runs through by the north side of Wallhouse, and which is seen again at Avon Bridge; this is to the north of the Bridgehouse dyke. The large mass of trap which lies on the north-side of Boarbachlaw Water extends from Shotts Kirk and West Craig's Inn, and appears to join the trap of the Bathgate Hills. A pit was sunk in Burnbrae Park, on the lands of Wallhouse, to the depth of 5 fathoms. This seam, which is good blind coal, is 2 feet and ½ inch thick. It has not been worked to any great extent, and was considered well adapted for drying malt and oats. The strata in this pit were mostly composed of freestone, with a bed of shale lying above the coal and another below it. A bore was made 8 fathoms below the upper bed, in which coal was also found not very deep; it had a bastard bed of freestone below it. The same seam was wrought on the opposite side of the burn, on the lands of Crawhill, at a short distance from Crawhillhouse. It crops out to the north-east of the plantation called the "Desert," on the south bank of the Avon. Ironstone was wrought in this neighbourhood twelve years ago on the lands of Woodside, by an ingoing eye, within a few yards of Torphichen Bridge, on the south bank of the Avon, where it occurs in the form of balls.

[The remaining part of this Essay, together with a coloured Geological Map of West Lothian, and a few Sections of Rock Strata, will be given in the following Number.—ED.]


Explanation
Trap Rocks
Stratified Rocks
Limestone
Lines of General Sections
Dip of Strata
Anticlinal Line
FIRTH OF FORTH
BORROWSTOUNNESS
CARRIDEN
ABERCORN
DALMENY
Edinburgh & Glasgow Railway
Low Water Mark
Linlithgow Bridge
Muiravonside
Livingston Ho.
Mid Calder
East Calder
Kirkliston
Black L.
GEOLOGICAL MAP
OF
WEST LOTHIAN
BY
CHARLES FORSYTH ESQ.R

PLATE V.


GENERAL SECTIONS
Rowden Hill
Bathgate Hills
Bathgate
Fault
Bathville Coal
Petershill Limestone
Bathgate Coal
Explanation
Stratified Rocks
Coal
Limestone
Ironstone
Crofthead Coal
Crofthead Slaty Black Band Ironstone
Shotts Lower or Stinking Coal
Wood Muir & Longford Coal
Trap Dyke at Scola Burn
Don Hill Coal
at City Farm

ON THE MINES, MINERALS, AND GEOLOGY OF WEST LOTHIAN

By Charles Forsyth, Esq., Advocate.

(Concluded from last Number.)

Hardhill Coal.

At Hardhill colliery, about a mile west from Bathgate, there are two workable beds of coal, both of excellent quality. The upper seam, which is the one at present worked, is found at 16 fathoms deep, and the lower seam at 21 fathoms, and dip to the north-west 1 foot in 12. Some faults occur in this field. The largest is what is termed the "main dyke," which runs from south-east to north-west, the depth of which has not as yet been ascertained. Some of these faults run nearly in a line with the dip and rise, and others in the direction or "streak" of the bed, as it is termed by the miners. A remarkable "stage," as it is termed, occurs in the bed towards the rise, the coal being thrown up 4 feet, and, a short way further on, thrown down again 4 feet, the coal in the intermediate space being elevated above the usual position of the bed, and in a line running in the direction of the strata.

Boghead Coal.

The next in order after Hardhill coal is Boghead coal-field, the highest seam of which is parrot coal, formerly worked, 10 fathoms below which Boghead coal is found. There have been 5 pits wrought in this coal, and there are at present 2 pits in use—an engine-pit, 24 fathoms deep, and a working pit to the south-west of the engine-pit 20 fathoms deep. It is a rough coal, and dips to the north 1 foot in 10.

The bed of coal which is at present worked at Boghead was wor ed not very far to the north of Boghead march, by the next proprietor, Mr Wallace. There were two pits sunk. In the one which was nearest Boghead, coal about 10 inches thick was found about 10 fathoms from the surface; it was found to dip towards the Boghead coal-field 1 foot in 3, in consequence of a fault 4 or 5 yards east from the pit, running from north-east to south-west, which threw up the coal so near the surface that it became unworkable. This appears to be a continuation of the fault which is found on the north side of the Hardhill coal-field.

Torbanhill and Inchcorse Coal.

Coal, apparently of a somewhat different class from those now mentioned, occurs to the south of these beds. A pit was lately sunk to the north-west of Torbanhill-house. It was made under the superintendence of Mr Geddes, mining-engineer, Edinburgh, and was sunk to the depth of 7 fathoms; but, in consequence of

the roof being composed of a soft brittle rock, it was found to be impossible to work the coal.

A pit 14 fathoms deep was next sunk on the lands of Torbanhill, further to the north-east, near the road from Bathgate to East Whitburn. There is a dull or parroty seam at the bottom of this bed of coal, whereas when such a seam occurs it usually does so at the top of the bed. It dips to the north-west 1 foot in 10, and is worked in the long-wall manner, the bed being 3 feet thick.

The same bed of coal which is at present worked at Torbanhill has also been worked at Inchcorse, on the east side of the road from Bathgate to East Whitburn, not far from Torbanhill colliery. Being nearer the crop than Torbanhill pit, it is only 6 fathoms deep.

A bore was made by Mr Fleming, at what is termed on the county map "Bathgate Market-place." It was 60 fathoms deep, but no coal was found. But very near the same place, on lands belonging to Mr Wallace, a little further west, a bore was made 28 fathoms deep, in which a seam of coal 9 inches thick was found 9 fathoms from the surface, and at the bottom of the bore there were 3 feet of blase, and then coal 2½ feet thick, dipping to the north-west.

Bathgate, Balbardie, Ballencreiff, and Hilderstone Hills Coal.

The next in order is a bed of coal which was formerly wrought below the town of Bathgate. This coal is about 6 feet thick, and dips north-west 1 fathom in 3. The old engine-pit was 30 fathoms deep, and stood at the east end of Bathgate. The working pit was where the Bathgate post-office now stands. A number of the houses are rent in consequence of the subsiding of these workings. There were 16 rooms below a street called the "Shuttlerow." There are said to be 6 seams in the Bathgate coal-field, and there are a great many faults, or hitches, or troubles in it. The same seam was worked farther to the north, on the lands of Balbardie, which was called Ballencreiff coal. These old workings are seen uncovered in Balbardie freestone quarry, where there are two old pits. The freestone in this quarry is remarkably good, and was used for building the viaduct on the Edinburgh and Glasgow Railway in 1840, where it crosses the Almond. There is a seam of black-band ironstone found in this quarry, lying between the rough coal and a seam of parrot coal. It is from 4 to 5 inches thick, and to the eye no difference is observable between it and Airdrie black-band: it is sent to the Shotts Ironworks, and considered of excellent quality. In this neigbourhood ironstone balls are found on the side of Bathgate Water, about 200 yards to the north-west of Ballen-

creiff Mill, and also at a few feet from the surface, a little to the north-east of Inchcorse-house. There is a fault to the south of Balbardie quarry, which throws an overlying bed of freestone down lower than the bed which is quarried. This seam of coal, which was worked at these two places, crops out at the back of Bathgate manse, where it was at one time worked to a small extent, but had a bad roof. It is also seen cropping out behind Glenmavis distillery, and runs below Gateshiel limekilns, and then by Ballencreiff colliery; it is then seen cropping out at the east of the Hilderstone colliers' houses.

This bed of coal is at present worked at Ballencreiff, where the coal has been worked from a very early period. The pit is 47 fathoms deep; there is also a stair-pit, and several old pits. The seam, which is 6 feet thick, has some ribs of stone in it, and dips north-west 1 fathom in 3, and is worked stoop-and-room. There are a number of faults in this field, the direction of which is generally in the line of dip and rise. There is a hitch, which is the height of the coal, about 7 fathoms to the north of the pit. There is also a down hitch, more than the height of the coal, about 20 fathoms to the north of the pit, and there is a large fault to the south of the pit, in which a mine was run to the distance of 15 fathoms, but was not through it. There is also supposed to be a whin dyke, which is understood to run north-east and south-west, near the road from Bathgate to Linlithgow, west from the pit.

The next in order is Hilderstone Hills coal. At the east side of the colliers' houses at Hilderstone, old workings in the small seams of the Hilderstone coal are seen where they crop out in Hilderstone freestone quarry; the upper seam is the red and the lower is the black coal. This is understood to be the same as Ballencrieff coal, being of the same thickness, and having also a stone in the centre of it. The pit is 60 fathoms deep; the seam which is at present wrought is 32 fathoms from the surface; it is 2 feet 2 inches thick, and dips north-west 1 foot in 2½ feet. It is only used for burning limestone, and is worked stoop-and-room. There is another pit, 44 fathoms deep, not now used, which is to the main coal, and also a stair-pit to the present working pit. There are a number of faults in this field. There is a hitch of from 4 inches to 9 feet deep, every 27 fathoms; they run through the whole of the beds, and there is a fault, 139 yards south from the present working pit, which throws the coal up to the south.

As has been shewn in the preceding account of the different collieries, a good deal of irregularity occurs in the coal-fields in the neighbourhood of Bathgate, which causes considerable difficulty in attempting to trace the relative connexion of the various beds with each other and with those of the district around. In

considering the question whether this field is connected with the Crofthead minerals, a number of circumstances must be kept in view. It will be observed that the latter are intimately connected with the Shotts field, which is totally disconnected with that of Bathgate, and that the slaty band appears to terminate on the north-east towards the rise, but may still continue to extend northward towards the dip, as it probably forms an extensive basin to the bottom of the series to which it belongs. As previously stated, the slaty-band is said to have been found near Cult and at Heads-farm, but no proper investigation appears as yet to have been made as to this. There seems little reason to doubt that coal occurs all round Whitburn, which may probably belong to the slaty-band series, that is, to the seams of coal which occur between the Shotts field and the slaty-band ironstone. One remarkable circumstance is the similarity between the Crofthead coal and that of Torbanhill, and that both have a dead or parroty seam at the bottom, whereas, as has been previously stated, when such a seam occurs, it usually does so at the top of the bed. Another important point in regard to this question is the position of the beds of the Bathgate field and their relation to each other, which it is very necessary to keep in view, in order to determine whether they form a separate basin or are merely a detached portion of the great western coal-field. This field is bounded on the east by the Bathgate Hills, which are composed of traprocks, along the base of which the coal measures recline and dip to the north-west; and in these hills the great main post of limestone is found which forms the bottom of the series. It is bounded on the west by a line of trap running from Shotts to near Avon Bridge, along the line of which the strata dip to the north-east. The strata thus appear to assume the form of a basin inclined to the north, and the supposition that the strata do here assume that form is strengthened by the fact that Boghead, Bathville, and Boarbachlaw Mill coal, appear to be the same. The coal at Bathville is not so well known as the others, as it has not been worked for many years; but it is understood to dip to the north, and is found cropping out to the south near Stanrigg. The strata appear to be a good deal deranged at this point, which may perhaps be supposed to have been caused by the traprocks at the western limits of the field, but it must also be observed that the strata are by no means inclined directly towards these igneous rocks. The supposition that these beds of coal belong to a separate basin, must, of course, exclude the idea that they are directly connected with the slaty-band series. Black-band has indeed been found in connexion with them at Balbardie, but the seam which occurs there has, as was already stated, more the character of Airdrie black-band. There now, however, appears little reason to believe that black-band occurs

to so limited an extent as it was at one time supposed to do; and in this instance it occurs near a bed of coal which is almost immediately above the main post of limestone.

Coal is said to have been at one time worked to a small extent near Cathlaw House, and there is a detached portion of coal at Kipps, where, as it appears from Sir William Sibbald's history of the county, published at the commencement of the eighteenth century, coal was worked at a very early period. A pit has been lately sunk at Kipps, where the strata dip to the north-west 1 foot in 3. There is an old pit a short way east from this pit, which is 10 fathoms deep, in which a bed of coal, lying above the seam the present pit is sunk to, was formerly worked, but after a few months it was found impossible to carry it on, in consequence of the excessive number of faults in the field. In the south mine, which was 35 yards long, the following remarkable series of faults occurred:—First a hitch 3 feet down; then a saddle hitch; then another 6 feet of hard blue stone, containing balls of ironstone; then 6 feet of foul coal, like soot; then another hitch, the roof coming down 6 inches; then 3 feet of good coal; then 11 fathoms of "vise" of coal, followed through firm fire-clay, containing ironstone balls imbedded in it; then 6 fathoms of good coal, very hard and 2½ feet thick; then a hitch thrown up, 4 inches of coal running forward, with blue fire-clay and freestone below it; then 6 yards of fault, consisting of blue fire-clay, containing ironstone balls, and 9 inches of coal above the fireclay, running forward; then a fault 2½ feet down, 3 feet thick; then 8 inches of coal; then, through an old working, having rooms 4 feet wide, and stoops or pillars about 4 feet square, where the workings in this mine were stopped. In the north mine, which was 25 fathoms long, there were 6 fathoms of good coal 33 inches thick, with a seam of parrot below the coal 3 inches thick; then a fault thrown down 3 feet; then bastard limestone 9 inches thick, running through this fault; then freestone thrown down 2 feet, and 4 feet thick; then coal 32 inches thick, parrot and rough mixed, which continued good for 9 feet; then a dyke of blue marl 10 yards thick; then coal 2½ feet thick, good for 9 feet; then a "stage" 9 inches thick, then coal in exactly the same position as on the other side, which continued good for 9 feet; then a dyke of blue fire-clay 4 feet thick; then coal in the same position as on the other side 18 inches thick, which continued good for 9 feet forward; then a dyke of freestone 18 inches thick, running in a line with the dip and rise; then coal on the other side of this dyke 1 foot 4 inches thick, good for 6 feet; then a dyke running in a line with the dip and rise 4 inches thick; then coal 9 inches thick, good for 4 feet; then the coal thrown down 2 inches by a slip; then, by piercing through to the back of the slip, the coal was found to be 19 inches thick: it was then given up.

There is a field of coal at Woodmuir and Longford, at the western extremity of the county of Edinburgh, which appears to be connected with the coal-fields of West Lothian, and it may, therefore, be proper that the nature of it should be here stated, in order to trace its connexion with the coal-fields of West Lothian, and more especially as it does not appear to be particularly connected with the coal-fields of any other district. There are a number of pits at Woodmuir, which are all level free; these pits are 28 fathoms deep. The present working pit is 16 fathoms deep; the crop seam only is worked at present. There are four seams of coal; the upper seam is splint coal of good quality; it lies 23 fathoms from the surface, and is 18 inches thick. The second, which is the main coal, is a sort of splint coal; it is 25 fathoms 3 feet from the surface, and is 3 feet thick. The third, which is smithy coal, is 27 fathoms from the surface, and is 28 inches thick. The fourth is 4 feet thick, having a division of fire-clay in the centre, varying from 16 inches to 3 feet, and also a hard ply of stone, below which the coal is from 22 to 32 inches thick, and it has been all worked together. The whole of the coal at this place which is of any value as household coal has been wrought out. There are some faults in this field; there is a fault on the north side of it 11 fathoms down to the south, and also a fault on the south side of the field which is 28 fathoms up to the south. The coal workings lie all between these faults. Near the north fault, on the south side of it, there are a number of slips, but none near the south fault.

In the Longford field there are what were called the east and west field workings at Blawweary. A steam-engine was used at these places, being moved from the one field to the other when found necessary. There is a large fault on the south side of the workings in the east field, on the south of which the coal was never properly found; and there are also a number of slips, but not many, in the west field. The coal is wrought out at both of these places. A pit is at present in process of being sunk, about a quarter of a mile north-east from Longford old pits, to the seam which was worked at that place. It is intended to be 18 fathoms in depth, in order to reach a rough coal. An atmospheric engine of 10-horse power has been erected for pumping and winding. There are three seams, two of rough and one of splint coal, which dip to the north-west 1 foot in 4½, and there are some faults in the field which run in the same direction. There is a fault on the south side of the pit, between it and the old workings, which throws the coal down to the south about 7 fathoms. An excellent section of the strata in this field is seen in Scola Burn, a short way to the east of the new pit. On the side of this burn part of a fossil tree is exposed about five feet long, having the slender end inclined downward; it is 9 inches

thick across the upper or thick end, and 4 inches across the lower end. The cross seam of the Longford coal was at one time worked in this burn by a day level, and the last time it was worked an engine was used. Through these old workings the water from Scola Burn is sometimes apt to enter the new pit.

There is an overlying bed of trap, which runs from the lands of Newhouse by Adiewell to Blackburn; it is seen in a quarry at the south-east end of the bridge, where the road by Adiewell and Brucefield crosses Scola Burn, and also on the south bank of Breich Water, a short way above Newmill. There are a number of beds of slaty sandstone, limestone, and indurated claystone seen cropping out near the foot of Scola Burn, between Scola Burn Bridge and Breich Water. They dip north-west, at an angle of 25°, and are seen in the bed of the burn immediately overlying the trap. Above these beds blind coal occurs, and then a thick bed of slate clay, above which the Longford rough and splint coal is seen in Breich Water, quite unaffected by the trap. This appears to be the same bed of coal with that which was worked near where Blackburn cotton-mill now stands.

About 40 fathoms below this bed of overlying traprock, which intervenes between the strata at this place, there are a number of beds of coal found on the banks of Breich Water, at Adiewell and Cuthil. This place is the next in order at which coal has been worked immediately below the slaty-band series in West Lothian. In all probability coal may be found in this intermediate space, that is, between Longridge and Cuthil, but at what depth is uncertain, in consequence of the very thick beds of sandstone which occur below the slaty-band series. This sandstone is seen in Rushy Hill quarry at Breich Bridge, and a horizontal bed of sandstone, lying quite near the surface, is seen immediately to the west of Longridge.

Adiewell and Blackburn Coals.

Coal was formerly worked at Adiewell, on the south side of Breich Water, near Cuthil Bridge, where there are several seams of coal. The workings were kept free of water by a day level which comes out on the water side, about 20 yards below the bridge. It appears to have been worked by an ingoing eye, the entrance of which is seen near the water side, opposite Newmill, and the coal, where seen at the entrance, is 3 feet thick, and dips to the north-west at an angle of 20°. On the north side of the water, a short way below Newmill, where a section of the strata is seen, there is a shift of about 3 feet.

Several pits were sunk near Cuthil Bridge, in the years 1837 and 1839, in which coal and limestone were found, but never worked to any extent. This coal appears to be the same with that which has been worked at Baadsmill, in the county of Edin-

burgh, and at Easter House, where ironstone occurs between the coal and the limestone. Coal similar to Adiewell coal occurs also at Blackburn, where it had, at one time, been worked in the lands of Blackburnhall, where old workings were formerly seen in a freestone quarry near the Almond Water. Coal was also formerly worked at Hopefield, which was called Blackburn coal-work, and in the lands of Red House, where only the crop of the seam was worked. These beds of coal appear all to belong to one series, as at all the places now mentioned it has beds of limestone connected with it, all of which are of a similar nature, and many of the beds are almost entirely composed of encrinites. Several of the beds of limestone connected with this series are of considerable depth, and have been worked at different places in the neighbourhood of Blackburn, where kilns were erected for the purpose of burning it. A good section of the strata belonging to this coal-field occurs in the bed of the Almond Water, below the village of Blackburn. The out-cropping of several of the upper seams are seen dipping immediately under a trap-dyke which occurs at that place, and a great number of seams of clay-band, and balls of ironstone of excellent quality, occur in numerous beds of shale and slate-clay. About 33 fathoms below the bed of limestone which has been worked at Blackburn, there is a bed of caking coal, 6 feet thick, having a thin seam of stone in the centre of it, which was formerly worked at Hopefield. This is the principal seam of the Blackburn coal-field, and dips north-west 1 foot in 3. An engine was used for pumping the water. The unusual circumstance of limestone lying immediately above the coal, and forming the roof, here occurs.

The lowest bed of coal which occurs in regular order below the Adiewell and Blackburn coal, and dipping in the same direction, is Dowhill coal, which was formerly worked near Breich Water, in the lands of Westwood, where there were a number of pits. This bed of coal is seen cropping out on the side of Breich Water, where it appears to be about 6 feet thick, having a foot of stone in the heart of it, and dips north-west 1 foot in 3. At Breich Mill, near the same place, but lying above the coal, there is a deep bed of clay-stone and fire-clay, some of it being of that kind which is usually termed by miners "stone-marl;" and about a dozen seams of ironstone, varying from 2 to 4 inches thick, occur in a deep bed of shale and slate-clay. These beds of clay-stone, &c., are very similar to a number of deep beds of claystone which occur in the bed of the Almond, at Red House, Blackburn House, &c. A short way below this line, the dip of the strata changes its direction from north-west to south-east.

Almost the only dyke, properly so called, which occurs in this neighbourhood, is a very remarkable one which crosses the bed

of the Almond immediately to the south of Blackburn House. It is composed of claystone, and runs from south-east to north-west. The strata on each side of it are found in a vertical position and running in a line with the dyke, but, a few yards further off, resume their usual direction, which is from south-west to north-east.

In regard to the beds of coal which occur at the western extremity of the county of Edinburgh, at Woodmuir and Longford, it has already been stated that they appear to be connected with the coal-fields of West Lothian. Although probably very low in the series, they do not appear to belong to the beds which are found at Adiewell and Blackburn, as the latter are found in connexion with limestone, whilst the former are not. So far as can be judged from the apparent relative position of the Woodmuir and Longford beds, where found in the bed of the Breich Water, as previously stated, it appears highly probable that they are connected with some of the lower beds of the Bathgate field. The beds of coal found at Adiewell and Blackburn appear, from the circumstance of their being interstratified with limestone, to be at the bottom of the series. So far as can be judged from the appearance of the strata connected with the bed of coal formerly worked at the town of Bathgate, there seems to be every reason for concluding that other beds of coal, probably connected with limestone, occur between the Bathgate coal and the great main post of carboniferous limestone which is found in the Bathgate hills, and that to these beds of coal the Adiewell and Blackburn coal belong, and also the coal found at Kipps. There is another bed of coal, previously mentioned, which lies below the Adiewell and Blackburn coal, called the Dowhill coal. This coal does not appear to be connected with limestone, but is connected with a series of beds, of which claystone and shale are the most predominant, which are found to occur on both sides of the line, where the dip of the strata changes from north-west to south-east. From this circumstance it has been inferred that this coal belongs to the series of strata which occur chiefly in the form of basins, in the eastern part of the county, and where the principal bed of coal is, as at Dowhill, chiefly composed of smithy or caking coal, having a stone in the heart of it. This point is more a matter of speculation than of any practical importance; but is of considerable interest when viewed as affording an opportunity of tracing the connexion of the strata which occur at the east, with those which occur at the western part of the county, between which there is a marked difference.

Borrowstownness Coal-Field.

The only coal-field of any extent, which reaches to the margin of the river Forth, is an extensive coal-field situated chiefly in

the estates belonging to the Duke of Hamilton and Mr Cadell of Grange. It extends from east to west between the lands of Carriden and the foot of Avon Water, and from north to south between the river Forth and the high ground to the north of the town of Linlithgow. This coal-field has been worked from a very early period and to a great extent. It consists properly of two fields of coal, known as the east and west fields, which together contain eight workable seams of coal, most of which is of excellent quality. The seams of the west field are the splint coal, 3 feet thick, the Corbyhall coal, 5 feet thick, the seven-feet coal, the little coal, not workable, and the wester main coal, which is said to be 12 feet thick. The seams of the east field are the red coal, 30 inches to 3 feet thick; the foul coal, 5½ feet thick, having a number of ribs of stone in it, for which reason it is called the foul coal—it is a mixture of splint and rough; the smithy coal, 33 inches thick, and last, Coursey coal, 1 foot 6 inches thick. There have, at different periods, been a great number of pits sunk to the various seams of coal. The pits to the west of Borrowstownness were all in the upper seams or west field. The farthest west of these, called the wester engine-pit, was situated where Borrowstownness distillery now stands; the east one, called Corbyhall pit, was situated a little west from Borrowstownness church, and both of these pits were near the water side; there were also, at one time, pits in the wester seams farther to the south. The first pit worked in the easter seams, called Schoolyard pit, was situated in the town of Borrowstownness; the next pit worked in the east seams was Grange Pans pit, close on the shore at the east end of Grangepans, 44 fathoms deep, to the main coal, and 60 fathoms to the smithy coal.

The coal at present worked is to the south of the old workings, which are situated on the water side, and rather to the rise about 10 fathoms perpendicular, and they are situated to the south-east of Borrowstownness. The next pit in the easter main coal after Grange Pans pit was Mingle pit, 80 fathoms deep, in which the easter main coal and part of the foul coal was worked. The next pit was Burn pit, 70 fathoms deep, in which the easter main coal is at present worked, and part of the smithy coal has been worked, but is not worked at present.

The faults in this field consist of dykes and slips. The dykes are composed of a very hard quartzy substance, and vary from 1 inch to 8 inches in thickness, but they are chiefly from 1 to 2 inches thick, and generally run in the direction of the dip. A few of them run in the streak, that is, in the direction of the strata; these are end dykes, and commonly about the same thickness. The coal is generally coarser near these dykes, in whichever direction they run. The faults generally run in the direc-

tion of the dip, and vary in depth from a few inches to many fathoms. A few of them are end slips, that is, slips which run in a line with the direction of the strata. The coal is very much hardened near these end slips for a considerable distance, but it is not so much affected near the slips which run in the direction of the dip. The smithy coal has been worked in the long-wall manner, but all the other seams by stoop-and-room. A considerable part of this field has been worked below the level of the water-engine-pit, that is, of Mingle pit. The strata of this coal-field generally dip west-south-west, 1 foot in 8; but where there is a change on the surface it is usually also perceived in the minerals below. Thus, at the high ground south from Borrowstownness, the dip is increased to about 1 foot in 5. A remarkable peculiarity in regard to this coal-field is the occurrence of beds of greenstone interstratified with the coal measures. They vary from a few feet to several fathoms in depth, and have, in several instances, been passed through in the pits. In regard to the amount of coal which has been worked in this field, generally it may be stated that the easter main coal is all worked out to the east of Borrowstownness old engine-pit, near to Bridgeness on the shore, and nearly as far east as Muirhouse to the south of Bridgeness, that is, to the east of the present working pits. Part of this coal lies also on the lands of Carriden, where little of it has been worked. The whole of the seams of coal along the shore and far south, are worked out, to the south of which the same seams are worked by the present mining. A quantity of foul coal has also been worked in Mingle pit, and a considerable quantity of smithy coal has been worked in Burn pit, and the whole of the red coal is worked out to the east of Mingle pit. A part of the red coal has also been worked in Schoolyard pit, but there is still a large field of it to work in that pit. This red coal crops out before it reaches Grange Pans pit. There is a bed of ironstone above the red coal, from 8 inches to 1 foot thick, lying in blase, above which there are from 18 inches to 2 feet of blase, and then a bed of black-band ironstone, from 4 to 5 inches thick. This ironstone does not extend over the whole field, but is only found along the north side of it. Above the foul coal there are 3 feet of blase, and then a bed of black-band ironstone 1 foot thick, above which there are from 1 foot to 13 inches of parrot coal.

Coal was lately attempted to be worked near Linlithgow Bridge, but with little success, and two pits were eventually sunk a short way to the north of Bonnington distillery to a small portion of the Borrowstownness coal which occurs there on the south side of the high ground, between Linlithgow and Borrowstownness, but which were also soon given up.

Carboniferous Limestone.

Connected with the coal-fields which have now been described, and lying at the bottom of the series to which they belong, there are two beds or deposits of limestone, the upper one of which is a bed of limestone which occurs at Levenseat, in the county of Edinburgh, and at Carriber and Bowdenhill, in the parish of Torphichen and county of Linlithgow. The limestone at these places is remarkably similar in character and appearance, and, so far as yet discovered, contains few or no organic remains.

Carriber and Bowden Limestone.—At Carriber the limestone is worked by a mine.

This bed lies in a trough inclined to the north-west. There are some "hitches" in it, from 1 to 1½ feet.

The same bed is mined to the south below Bowden Hill, where the mine is 200 yards long, at the entrance to which the limestone appears with a bed of shale above it, upon which the greenstone of Bowden Hill rests. The limestone also rises in a trough similar to that of Carriber. It was at one time proposed to drain the loch at Lochcott, which lies on the south side of the hill, by means of this mine, near which place this limestone was also at one time worked to a considerable extent.

The principal bed or post of limestone connected with the coal measures of this district is an extensive series which runs through the Bathgate Hills, from south-west to north-east, from near Bathgate to a short way south from the town of Linlithgow, and which dips to the north-west at various angles. This is the shell limestone, or great main post of the carboniferous limestone, and appears to belong to the same series with the limestone at Charlestown, in the county of Fife, and it may be here remarked that there seems to be a great similarity between the coal-formations of West Lothian and of Fifeshire. The southern point at which this limestone occurs in the Bathgate Hills is at the old quarries at Kirkliston, where the limestone is found in immediate contact with trap, and the effect produced is very remarkable.

Peterhill, Gateshiel, Silvermine, and Hillhouse Limestone.—About half-a-mile north-west from Kirktown, another bed of limestone occurs, which is worked at Peterhill and South Gateshiel, where it dips somewhat irregularly, from 1 foot in 2½ to 1 foot in 4. The under part of this limestone is the best in quality. There is a large dyke of tufaceous rock runs through South Gateshiel quarry. Limestone has also been quarried in a line extending from Galabraes to Mounteerie, near to which latter place it is at present worked, called North Gateshiel new quarry. Gate-

shiel limestone is of the same series with Peterhill limestone, but a higher bed. It lies below greenstone, which is seen about 200 yards north from Sunnyside, and immediately above the quarry at the east end, where the greenstone lies above a bed of shale; the limestone, at this point rests upon the trap of Blackhill, and dips north-west 1 foot in 3. There are two great dykes running through it in a line with the dip—one 10 yards and the other 8 feet thick. These dykes are composed of a sort of tufaceous felspar, in some places highly indurated, and having a burnt ochrey appearance. There are also two smaller dykes, composed of sandstone, which are about 8 feet apart, and run nearly in the same direction—one from 1 foot to 1½ foot, the other 6 inches thick. The strata in North Gateshiel new quarry occur in the following order:—

	Fath	Feet	In.
1. Clay,	2	1	–
2. Shale,	1	5	9
3. Irregular band of Ironstone,	–	–	3
4. Shale,	–	1	4
5. Limestone,	–	3	–
6. Inferior Limestone of a flinty nature,	1	3	–
7. Good Limestone,	6	2	–
8. Very good Limestone,	1	2	–

The next point at which this limestone is worked is at South Silvermine, which is the same series of limestone, but apparently different beds from those in North Gateshiel new quarry. It dips north-west 1 foot in 3½, and the quarry is nearly worked out in consequence of the depth of surface deposit which lies above it. There is a hitch about 2 feet up to the south, which runs through the whole of the beds at the south end of the quarry; and there is a freestone dyke, about 1 foot thick, which runs nearly in a line with the crop. The strata in South Silvermine quarry occur in the following order:—

	Fath.	Feet	In.
1. Clay,	1	1	–
2. Shale,	1	1	–
3. Slaty Sandstone,	1	4	–
4. Shale,	5	–	–
5. Freestone,	–	8	–
6. Fire Clay,	–	3	–
7. Limestone,	1	2	–
8. Limestone, with balls of flint,	–	2	6
9. Limestone,	1	2	–
10. Red Limestone, with a seam of flint 8 in. thick,	–	3	6
11. Brittle Limestone,	–	3	–
12. Limestone,	–	2	6
13. Very good Limestone,	–	2	–
14. Do.	–	2	2
15. Do.	–	2	8
16. Do.	–	4	8

The same beds of limestone are quarried further to the north. There is nothing but surface clay above the limestone at this point. The clay is about 30 feet thick, and the beds of limestone are in all 35 feet thick, and of good quality. This is called North Silvermine quarry. Between North and South Silvermine quarries, there is an old quarry in which a fault occurs. In this old quarry there is a bed of limestone containing lead ore, which was at one time worked for the purpose of extracting silver from it. When the South Silvermine was opened, pieces of silver ore were found mixed with lead in veins running through

the limestone. Limestone has also been worked at Wardlaw, farther north, in a bed which appears to lie above those which occur at Silvermine, and it is also seen to the north of Cairnnaple Hill. A bed of limestone also occurs to the eastward, between the farm-houses of Tartravens and Southmains, where it was formerly worked to a considerable extent. The next point at which this limestone has been worked in a direct line north from Silvermine is at Bormie and Hillhouse. At Hillhouse the limestone was first worked open-cast and is now mined. It dips north-west 1 foot in 3. There are 3 dykes in this quarry, two of which are similar to those which occur at North Gateshiel new quarry, the north one is 2 feet and the south one is 5 feet thick, and the band, which is composed of flinty limestone, is about 60 yards south from the others. It is 4 feet thick at the surface, and gradually ceases towards the dip. The limestone is very hard near these dykes. The limestone lies under beautiful basaltic columns, and the strata at the point of contact is much contorted. The limestone is of much better quality on the south side of the dykes than it is on the north of them. There are also a number of small hitches, none of them more than a foot, which run nearly in the same direction with the dykes, the strata vary very much in thickness at different parts, and occur in the following order:—

	Fath.	Feet.	In.
1. Beautifully regular, slender basaltic columns, varying from 6 to 30 feet in length, ...	–	–	–
2. Slaty Sandstone, . . .	–	–	–
3. Shale, ...	–	–	–
4. Soft Claystone or Marl,	–	–	–
5. Slaty Sandstone, . . .	–	–	–
6. Shale, ...	–	–	–
7. Freestone, ...	–	–	–
8. Very thin seam of Claystone, ...	–	–	–
9. Shale and Slaty Sandstone,	–	–	–
10. Soft Claystone or Marl,	–	–	–
11. Limestone, ...	–	2	–
12. Limestone, ...	–	–	8
13. Limestone, ...	–	3	–
14. Limestone, ...	–	2	–
15. Limestone, ...	–	5	–
16. Claystone, ...	–	–	2
17. Limestone, ...	–	2	–
18. Limestone, ...	–	2	–
19. Limestone, ...	–	4	–
20. Claystone, ...	–	–	–

The whole of the strata which have now been described appear to belong to one general series, and to underlie each other nearly in regular order, whereas, towards the eastern end of the county, the strata assume a totally different position; they are usually found in a very irregular state in that part of the country, and generally assume the form of basins. The point at which the strata change the direction of their inclination may be traced diagonally across the country in the direction of the strata, that is, from nearly south-west to north-east. The southern extremity of this anticlinal line is seen in the bed of Breich Water, about 100 yards above City farm-house, where the strata change the direction of their dip from north-west to south-east; and in the bed of the Almond, nearly opposite East Breich farmhouse, where the strata appear in a vertical position; and in the

Backburn, at Tarland Bridge, on the road from Long Livingstone to Bathgate, a bed of shale is seen cropping out almost on edge, but inclining slightly to the south-east; this bed is again seen cropping out at an angle of 18°, and a similar bed of shale is worked at Chucket Hall, for the purpose of making drains, whilst a short way to the north-west of this line, near Deans farm-house, where shale is also quarried for the purpose of making drains, the strata are found dipping to the north-west, thus pointing out the direction of the anticlinal line as passing between these two places. The bed of shale at Deans contains several thin seams of ironstone, and also ironstone balls, in the centre of which there is a dark nucleus surrounded by a number of concentric circles, similar to those found in shale at the sea-side at Wardie, near Edinburgh.

A short way east from the line now mentioned, a post of limestone occurs, which runs in a similar direction, and dips to the north-east. This limestone underlies the beds of coal which are found in the eastern parts of the county, the southern part at which it appears is at Barracks, where it was formerly quarried. It there dips at an angle of 18°, and, in consequence of its having so high an inclination, it soon became so deep, that it could not be profitably worked. This high angle of inclination occurs for a considerable distance on both sides of the anticlinal line. The next point at which this bed of limestone has been worked is at Carmendean farm, whence it has been worked in a continuous line through by Knightsridge, where it is at present worked by the proprietor for private use only, as it cannot be quarried to any great extent.

This limestone is next seen at the south-west end of the Binny Craig, and, continuing this line towards the north-east; it is also found at Niddry Castle, near Kirkliston; at Duddingston, which is called Newton Line, and also at Port Edgar. There is a bed of freestone which overlies this limestone, and at Entryhead, near Barracks, a sandstone conglomerate occurs in no proper line of stratification; and in the burn at Carmendean, where shale is quarried for making drains, a remarkable tortuosity occurs in the strata.

The coal in this district is found lying in basins, or rather parts of basins, which occur at Dechmont, West Binny, Stablegordon, Champfleurie, Oatridge, Houston, Pyotshall, Six-miletown, and Priestsinch; there appear also to have been pits near Livingstone, and at Letham farm near Mid-Calder. On the lands of Dechmont, 2 pits were sunk at Chucket Hall, immediately to the south of the Glasgow road at the 15-mile stone; but the coal, which was smithy coal, was not found to be of good quality, and consequently was not worked for any length of time.

Houston Coal, &c.

At Houston, the coal lies in two basins. It is at present worked in the east basin, where there are two pits about 22 fathoms deep. The bed of coal is divided by a seam of stone running through it, which is from 16 to 18 inches thick. The coal above the stone is household chews, and the coal below the stone is excellent smithy coal. The total depth of the bed, including the stone, is 5½ feet. The east basin runs from north-east to south-west, and crops up all round, but chiefly to the south-east and north-west. Blind coal has been found about 300 yards from the bottom of the pit. The coal is made "blind" at that place by a trap-dyke which runs by Uphall church, and crosses Houston Burn a little below the bridge at the Glasgow road, and which joins a large mass of trap near Harrey's-i-the-Muir. The coal in this basin crops out to the south west, where it appears to be cut off by a dyke. The roof is very bad at that place, and it has not been properly investigated. Beyond this the west basin commences, which has been worked to the south of Houston Mains, where there have been a number of pits. This basin is cut off on the south-west by trap, which occurs at Dechmont. The coal formerly worked at Dechmont belongs to this west basin, but it is there very much affected by the trap. The coal was of inferior quality on the south-west part of the west basin, apparently in consequence of its being near the trap. The sandstone comes up on the north-east and north-west of both of these basins. There are several bands of ironstone in the Houston basin.

There is a basin of coal at West Binny, and west from Wester Bangour, which has at one time been partially wrought to the south of Harthall, where old pits may be traced. This appears to be the same bed which was at one time worked on the lands of Ochiltree at Stablegordon, where it was lately attempted to be worked by an ingoing eye, which penetrated into old workings in which the best of the coal had been worked out at an early period, and what still remained was found unfit for the purpose for which it was intended, that of burning lime. The strata at this place dip to the north-west about 1 foot in 3. Sandstone belonging to this basin occurs in quarries at Broomie Knows and Kingcavel, and crops out at Riccarton farm-house. There is another basin of coal at East Binny, which extends also into the lands belonging to Lord Roseberry on the west, Lord Hopetoun on the east, and Sir James Dalziell on the north-west side, and it extends to Three-miletown by Waterston farm. On the lands of East Binny a pit was sunk about 20 fathoms deep, east from Oatridge farm-house, about 15 years ago, and another at the farm-house. In these pits 1 foot of coal was found, and

the rest of the bed passing into shale. This part of the basin lies between Binny Craig and the village of Ecclesmachen. At the east side of the basin, where the coal was of good quality, it has been worked by a level at a very ear y period. The entrance to this level is seen on the south side of the burn, north from East Binny House, where there appear to have been several level pits. The strata, where here exposed, contained bands of ironstone. Coal has also been worked at a very early period to the north of Oatridge, near Ecclesmachen Burn, where a water-wheel, which was worked by the water of the burn, was used for pumping. On the side of the burn, above the old level pits at East Binny, the claystone of the Houston field is seen in a very thick bed. There is a bed of limestone lying about 200 yards south from Binny Craig which has been worked at Broadlaw; it is 11 feet thick, and of a blackish colour. This is the continuation of the bed of limestone which occurs at Dechmont, and dips to the south-east. In making a level for the purpose of carrying off the water from this lime quarry old coal workings were found.

In the bed of the burn at Ecclesmachen, a bed of claystone occurs, in a semicircular form, lying up against the base of Torhill. On the side of the burn, a little above Ecclesmachen, there is black limestone dipping to the south-west; and on the south bank of the burn, at East Binny gate, beds of freestone and shale occur, dipping to the west, below greenstone. A little further down the burn, near Ecclesmachen manse, the strata dip to the east below a dyke of greenstone; this is the point where the East Binny basin terminates and the Pyotshall basin commences. There is an excellent freestone quarry at East Binny. Blocks are sometimes cut 17 tons in weight. The beds in the quarry dip west at an angle of 15°. There are 26 feet of good stone, above which there is a bed of hard sandstone 3 feet thick, and then shale 31 feet, and surface-clay 9 feet. The upper seams of the working bed have a slig' tly greyish colour; the lower, and by far the greater part of it, is of a fine white colour. Isolated masses of freestone, of a very hard nature, and somewhat different from the rest of the stone, occur in different parts of the beds. These isolated masses are generally coated with mineral pitch of a yellowish-brown colour. The stone of this quarry is used for buildings in Edinburgh and Glasgow; and, in consequence of its being of a beautiful close texture, it is much used for statues and ornamental carved work. The Scott Monument in Edinburgh is built of this stone. The Binny sandstone is cut off on the south by the trap-dyke which runs through Porkneuk farm, north from Houston, and which crosses the burn at Dechmont toll.

There is also another trap-dyke, which was previously mentioned, which cuts off the Houston basin at its south-eastern ex-

tremity. This is the dyke which crosses the Houston basin a short way below the bridge on the Glasgow road, where the strata of the Houston field are seen on edge. This dyke of trap is seen overlying the coal measures in a quarry at Uphall church; this is the out-cropping of the basin of coal which lies between Uphall and Broxburn. In this quarry a remarkable effect is seen to be produced upon the strata where in contact with the greenstone. At the point of contact there is a bed of ironstone about 2 feet thick, which is highly indurated, and has generally a reddish-brown burnt appearance, but in some places a greenish tinge. Below this band of ironstone, a bed of highly indurated slate-clay occurs 6 feet thick, and then a bed of blind coal 6 inches, then indurated claystone 6 feet, below which the coal of the Broxburn basin is found. This dyke, which is called the Uphall dyke, breaks up in a face, to the north-east of Uphall, rising towards the north-west. There is another dyke near Broxburn; it is seen at the bridge where the Union Canal crosses the burn, from which it extends towards the north, near the east side of Pyotshall, and by Parkend to Hayscraigs, where it breaks up to the east. The Broxburn basin lies between these two dykes, and several small dykes run between them. The places where a number of pits have been in this basin may be traced on the farm of Pyotshall. These pits appear to have been worked by a level opening to the south, and the coal is seen cropping out a little to the west of the east dyke. Black-band ironstone has been lately found by Mr Geddes, mining-engineer, Edinburgh, lying on the surface, at the place where these pits have been, thus shewing the important fact, that this valuable mineral occurs in this district. A pit was some years ago sunk, and an engine erected, at Newbigging farm-house, where several pits had been worked at an early period, by a level which issued at Ecclesmachen Burn. The coal was not long worked at this engine-pit, as it was found to be close to the old wastes. Almost the whole of this coal is blind, in consequence of being so near the greenstone dykes. Coal can be traced east from Broxburn; and coal has at some former period been worked at Hillend, in this neighbourhood, where there appear to have been two pits; and also north-east from Hillend, where old pits are seen. The furthest point to the north-east at which coal has as yet been found in this county is at Priestsinch.

Coal is at present worked at Priestsinch, but on a very limited scale. The pit is 16 fathoms deep. This coal is precisely similar to Houston coal. There is a band of clay ironstone, 6 inches thick, which lies above the coal, and is worked along with it.

An excellent opportunity for observing the nature of the strata in this neighbourhood occurs in the deep cuttings on the Edinburgh and Glasgow Railway, between Linlithgow and the viaduct

which crosses the valley of Almond near Newliston, and in the tunnel through Winchburgh Hill. The strata in this line consist chiefly of very deep beds of shale, slate-clay, and claystone, and at some places of beds of limestone of considerable depth. One bed of sandstone, of excellent quality and well suited for the various purposes of building bridges, walls, &c., on the line, has been passed through a short way west from Craigton Bridge; and near Priestsinch beds of black sandstone of considerable depth are passed through. This black sandstone, which contains a large quantity of minute scales of mica, and which, when cut, is of a deep black colour, appears to be peculiar to this district. It is also found in a quarry at Binns. Two seams of coal have been crossed by the railway in the neighbourhood of Priestsinch; one of these is 1 foot and the other 15 inches thick, but they are both very foul. Bands of ironstone, similar to those at Uphall, have also been passed through at the same place. That the beds of shale and claystone in this district are of very great depth has been proved by the remarkable circumstance that strata consisting of these substances alone have been passed through for many hundred yards south from Binns, although the cutting has been to the depth of 40 feet. A remarkable boulder of shell-limestone was found in the surface-clay at this place. The strata passed through in the tunnel at Winchburgh Hill consist of sandstone, shale, slateclay, and claystone, resting upon gréenstone, of which the hill is chiefly composed. The greenstone has been found chiefly towards the north and south ends of the tunnel. Some parts of it are excessively hard, and the overlying strata are in many places considerably indurated, and in some places, as towards the south end of the tunnel, the strata have a yellowish-red ochrey appearance. The tunnel is 1100 yards in length; near the south end of it a thick bed of shale occurs, dipping to the west, below which there is a thick bed of limestone, having a crystalized burned appearance, from being in contact with trap. This bed of limestone overlies beds of sandstone, and there is a fault at the point of contact, the limestone being thrown up to the south. These beds of sandstone rest upon the trap at Niddry Castle; and on the south side of this trap a bed of limestone has been found 2½ feet thick, which is combined with the trap, and rendered almost of the nature of porcelainite. To the south of this there is a deep bed of claystone conglomerate, and then beds of sandstone having a waved appearance, which extend to within a short way north from the viaduct. Limestone, apparently belonging to the bed which is crossed in the railway at Niddry Castle, has at one time been worked at Newliston, further to the east. There is also an extensive freestone quarry at Humbie. The stone was used for building the viaduct at Broxburn. The strata dip to the north, but do not lie in regular beds. This

sandstone contains balls of ironstone, some of which are of a very large size, and contain a large quantity of pyrites. These balls vary much in size, and contain also a considerable quantity of sulphur, which is strongly exhaled when they are broken.

In tracing the strata along the south-eastern limit of the county, in the bed of the Almond, from its junction with the Breich downwards, the coal measures, chiefly consisting of great beds of sandstone, are found dipping to the south-east, until reaching Almondell, where, a short way above the iron aqueduct, by which the feeder for the Union Canal is carried across the Almond, the strata are seen in the form of a semicircle facing the north, and nearly on edge in the bed of the river, and rising to a great height on the south bank, where the sandstone has a slightly reddish appearance, and is apparently considerably altered, as if from being in contact with trap. At Almondell Bridge the strata dip north-north-west at an angle of 20°. Opposite Almondell House the strata on the south bank of the river dip south-east, this being probably a part of the strata connected with the East Calder limestone. Immediately below Eliston the strata are found in a very remarkable position, being bent over somewhat in the form of a double arch. A short way below this point the strata dip north-west; and at the Almond aqueduct the bed of the river is entirely formed of a great bed of trap, which inclines slighty towards the north-north-west. This bed of trap, which is composed of greenstone, is surmounted by thick beds of slate-clay, which are slightly indurated at the point of contact. A few hundred yards below the aqueduct, a bed of greenstone, in the form of a dyke, crosses the river from north-west to south-east.

Below this point little opportunity occurs for observing the nature of the rocks in the bed of the river until reaching Craigie-hall, where the bed of the river, for some hundred yards, is formed of greenstone, between which and Cramond Bridge various strata, composed of shale and sandstone, occur, dipping to the west. The next point at which any rocks appear is in a freestone quarry at Craigiemill, where the strata dip to the north-east, below which the nature of the rocks can scarcely be traced, until reaching the village of Cramond, where greenstone occurs on the west side of the river.

In tracing the strata on the northern limit of the county along the side of the Forth, between Borrowstownness coal-field and the north of the river Almond, they are found to consist chiefly of beds of sandstone and shale, dipping to the west, until reaching Hopetoun House, where they are crossed by beds of trap. Trap occurs at Bridgeness Pier, at Carriden Church, and at Blackness Castle. There is a good freestone quarry on the shore at Carriden; and about 200 yards west from Blackness several beds of ironstone mixed with lime occur imbedded in shale.

This ironstone is used at Blackness for the purpose of making Roman cement. And near the same place ironstone was at one time worked by the Carron Iron Company. At Hopetoun House the strata are crossed by a bed of greenstone, immediately to the east of which there are a number of beds of limestone, shale, and slaty sandstone, which dip to the east. At Society there is a bed of limestone 6 feet thick, and between that place and South Queensferry the strata occur in a very irregular state along the shore, the direction of the dip of the strata varying from east to west and north every few yards, and they are crossed by a bed of greenstone near Hopetoun Fishery. Limestone is worked by mining at Port Edgar. There are two mines, one running to the east and the other to the south, each about 250 yards in length. The seam varies from 6 to 9 feet, and dips to the north-east. It is a very dark-coloured limestone, and contains some iron in it, which makes it well suited for making cement and for the iron furnace. It consists of three beds, the upper 2 feet, the middle 2½ feet, and the under bed from 4 feet to 4 feet 3 inches. There is a slight undulation in this limestone, and there is a dyke which runs through it from south-east to north-west. It is composed of sandstone conglomerate, which is divided in the centre by a vein of spar containing lead ore. This dyke branches off into two, one branch running nearly south, and the principal one running nearly north. There is one slip varying from 6 inches to 2 feet, which runs nearly in the same direction with the dyke. On the shore at the west end of Queensferry, two dykes, composed of limestone, are seen running in the direction of the strata, which consists of beds of sandstone which are bent over the top of these dykes, and rents or tears are seen in the strata running longitudinally on the top of the dykes. Limestone is worked at Newton in this neighbourhood. The bed, which is 10 feet thick, is found in undulations or cups. Shale was quarried thirty or forty years ago near Port Edgar, for the purpose of making alum, of which it contains a large quantity, and it is supposed that, by means of the method of manufacturing this substance which is now generally adopted, this shale could be used with considerable advantage. The minerals in this neighbourhood contain also a large quantity of sulphur. There is a shale drain at Newton farm which has stood for upwards of forty years without requiring repair. There appears to be an upthrow in the strata at Port Edgar Pier which probably cuts off Port Edgar limestone towards the east. Between South Queensferry and the foot of the Almond, the strata consist chiefly of beds of sandstone dipping to the west. These are crossed by beds of trap at three different places, the first of which occurs between Whitehouse Point and Hound Point, the second a little to the east of Langreen, and the third at the foot of the Almond.

Traprocks, and Geological Character of the District Generally.

Having thus given a detailed account of the mining operations of the district, and having endeavoured to trace out the connexion between the various strata in which they occur, we now come to consider the nature of the traprocks, their connexion with the coal measures, and the circumstances which have caused the stratified rocks to assume their present position.

The traprocks of West Lothian consist of greenstone, felspar rocks, and basalt. The greenstone is composed of minute crystals of agate and felspar, but it is very varied in its composition; sometimes the crystals are of a larger size, where it assumes a syenitic structure, at other times it contains large crystals of felspar, when it assumes a porphyritic structure. It is sometimes found in a regular or somewhat columnar form, at others of a rounded or globular form. The felspar rocks are of various kinds and varieties of composition, as in that of tufaceous and earthy felspar, more or less crystalized, and sometimes assuming a somewhat amygdaloidal structure, containing balls of earthy matter of various sizes, and also bituminous matter; and all of these rocks are more or less changed when in immediate contact with the stratified rocks. In such positions they not unfrequently assume a structure approaching to that of serpentine. Basalt, the most highly vitrified variety of these rocks, occurs also, but to no great extent; in some instances it is of a beautifully columnar form, and in others in masses or beds.

In a treatise such as the present, the object of which is to describe the minerals of a certain district and the peculiarities attending them, it is nearly impossible to avoid the introduction of speculative matter, as the observer, when investigating these phenomena, cannot avoid the assumption of some theory which shall appear to account for them, and whilst endeavouring to communicate an account of them to others, unless he shall, at the same time, state the views which shall then have occurred to him, he must do so in an imperfect manner. Whilst treating, therefore, of the connexion between the stratified and unstratified rocks, some of our remarks will be combined with more speculative matter than the preceding part of this essay.

The traprocks occur in the various forms of masses protruding through the stratified rocks—of overlying masses of various extents—of dykes passing through the strata in directions nearly corresponding to the line of inclination, and of beds interstratified with them. In endeavouring to trace out the limits of theseigneous rocks, considerable uncertainty must, of course, always occur, in consequence of the deep diluvial deposits which are generally superimposed on them; but it will be seen from the coloured map

that these rocks chiefly occur in the central part of the county, and that the overlying and interstratified masses usually occur in lines extending from north to south, which also is the general direction of the stratified rocks, and the effects produced upon them is very various. Whilst the strata in the south-western part of the county, where there are few traprocks, occur generally in a regular order, and dipping to the north-west, those of the eastern part are found in a most irregular state, and dipping in all directions; and the coal-field at the western part of the county, which is in immediate contact with a great mass of trap, is found to have various beds of greenstone interstratified with it. The Bathgate coal-fields are bounded on the north-west by a large extent of trap, which extends from Shotts to Torphichen, where it joins the trap of the Torphichen Hills, and the coal found at Wallhouse is converted by it into blind coal. There is a line of trap which is seen at Breich Water, near Adiewell, in the county of Edinburgh. This is an overlying bed, and is next seen in the bed of the Almond at Blackburn, where it assumes the character of a serpentine, and is quarried for making the floors or "*soles*" of ovens, as it stands great heat. This rock occurs somewhat in beds, is of a greenish-black colour, and when exposed to the sun and the air it crumbles down to earth in a few months. The seams which run through it contain asbestic hornblend, steatite, and crystals of calcareous spar. It is next seen a few hundred yards north from the village of Blackburn, where the upper part of it is composed of a felspar rock coloured with iron, the under part of it being similar to that found in the bed of the Almond. It next occurs at Bathgate, where it was found in a bore made in the lands of Inch, where it was similar to that at Blackburn. It also occurs in a quarry on the lands of Kirkton, where it assumes a much harder nature, approaching to basalt, and lies in beds dipping to the west at an angle of 45°, and is traversed by veins of grey asbestus at right angles to the dip. In the Bathgate Hills, which form the greater proportion of the traprocks of the district, various effects are produced by the contact of the stratified and unstratified rocks. The lower beds of the Bathgate coal-field are found reclining on the western extremity of them; and near Bathgate Academy the trap is found superimposed upon them. Various isolated portions of coal strata are found to be contained in the great mass of the traprocks, as at Cathlaw, Kipps, &c. An account of the old coal workings in the latter place has already been given, in order to shew the remarkable position in which the coal was there found to occur in a locality thus in a manner surrounded by traprocks. An excellent opportunity of observing the effects produced by the contact of

the limestone with the traprocks occurs in the great post of limestone which runs through these hills, and in the various beds connected with it.

The upper bed, which occurs at Lochcot, Bowden, and Carriber, is found underlying the trap of Bowdenhill. This hill is composed of greenstone, which, to a considerable extent, assumes a columnar form. It is hard, and is quarried to a considerable extent. What appear to be the lowest beds connected with the great main post of limestone are those found in the old lime quarries at Kirkton, where the limestone is found in immediate contact with trap; and a very remarkable effect is produced upon these stratified and unstratified rocks when in contact, which cannot be better described than it has been by Dr Hibbert, in a paper which was read before the Royal Society of Edinburgh in 1834, extracts from which have been published in Vol. xvi. No. 32, of the *Edinburgh Philosophical Journal.*

It may be added that this limestone, on examination, has been found to contain only a very small quantity of magnesia, which is very important in regard to agricultural purposes, in consequence of its injurious effects upon vegetation when contained in large quantities, as it is in some limestones; and also that, in consequence of the large quantity of siliceous matter contained in this limestone, it requires to have only a very small quantity of sand added to it in order to fit it for building purposes. Lying above this quarry there is a bed of trap, lying above which, a little further west, is Kirkton west quarry, in which the trap is also found superimposed upon the limestone, and where a somewhat similar effect is produced.

This lime-rock was referred to by Dr Hibbert, in support of the opinion entertained by him that some of the lower beds of the carboniferous limestone of the Lothians belong to a freshwater deposit. But this bed is one which, from local peculiarities, is rendered very unsuitable for being referred to as affording an opportunity of judging of the merits of a question such as this, from the circumstance that, as must appear from the very correct account of the phenomena attending it which have been referred to, the composition of that rock has been so much altered as almost entirely to exclude the possibility of judging as to what was the nature of its original composition. But in so far as we have been able to judge, from a careful examination of this locality, it does not appear that there are any substantial grounds for coming to the conclusion that this limestone deposit was formed under circumstances differing from those under which the other beds of limestone of the district, and the coal formation generally, have been formed; and in this opinion we have been strengthened by the fact of having found marine shells in a specimen composed almost entirely of ironstone obtained from this

quarry; and also from the circumstance of marine shells being found in a bed of shale which occurs immediately above this limestone, and that a bed of encrinal limestone occurs a short way above this bed, and intervenes between it and another bed of limestone, which occurs in an old lime quarry farther west, where the limestone is in a position similar to that already described.

At Peterhill quarry the angle of inclination of the limestone is considerably increased near the crop, where it apparently approaches the trap, and is considerably altered. The trap passes through the limestone in the direction of the dip at South Gateshiels quarry, in the form of a dyke of earthy felspar, in some parts highly indurated and of an ochrey appearance. Similar dykes also traverse North Gateshiels quarry near Mounteerie; and a dyke also passes through the limestone in the old quarry near Silvermine; and towards the north end of North Silvermine lime quarry, the limestone, which is naturally of a bluish-grey colour, is highly indurated and of a reddish colour, apparently in consequence of its being near a trap-dyke, which crosses the north end of it. On the road-side, immediately north from this, copper ore is said at one time to have been worked, in what appears, from the fragments found near the place, to have been a vein of barytes or heavy spar. After passing this point, the great main post has been quarried in a direct line, until it is again found at Bormie and Hillhouse; but limestone occurs at Tartravens, a considerable way east from this, and at Wardlaw, west from it. The limestone at Wardlaw is found in a remarkable position, being surrounded on all sides by trap. At Hillhouse, beautiful basaltic columns are found overlying the limestone, and a large dyke, similar to those which have been described as occurring at other quarries, passes through it, and considerably alters the limestone near it.

In connexion with the strata which occur in the eastern part of the county there are isolated portions of coal among the trap rocks of the Bathgate Hills at Ochiltree, West Binny, &c. The highest points connected with these hills are Cairnnaple, 906 feet above the level of the sea, Cocklearn Hill, 866 feet above the level of the sea, and Bowden Hill, a little lower, which are towards the western end of the range. There is a line of high ground between Linlithgow and Borrowstownness which is composed of trap, and a number of trap beds, intervening between the stratified rocks, are found at various points between the foot of Avon Water and Queensferry, and which are found numerously interstratified with the Borrowstownness coal-field. These beds appear to be very similar to those mentioned by Mr Landale, in his account of the geology of the East of Fife coal-field, as occurring near Kinghorn, and which were, as stated by him, "the great stronghold of the Neptunists."

On the road-side, near Borrowstownness, a bed of trap is seen traversing the strata, and affords an excellent opportunity of observing the peculiar effects caused by the contact of the trap with sandstone in this coal-field, and occurs thus, from the surface downwards: first, sandstone, just cropping out, and about 3 feet thick; then shale 6 feet; then trap 20 feet. The upper part of this bed is composed of tufaceous rock of a reddish-brown colour and amygdaloidal structure, containing crystals of quartz or chalcedony. The lower part of it is composed of greenstone, having the character of a serpentine, in large rounded masses, which are coated with a thin layer of chalcedony, which also occurs in veins and is full of cells. The lower part of the bed is a rock of that nature which has the local name of "Lakestone," and is used for the purpose of making oven "soles," as it stands great heat better than any other stone. Below this there is a bed of tufaceous rock about 2 feet thick, in thin layers, which contains a seam of sandstone 4 inches thick, which is termed the millstone-band or bastard-band. This bed has a slightly reddish tinge, is excessively hard, and contains, like the upper part of the trap, small crystals of quartz, and in many respects resembles the sandstone where in contact with the greenstone at Salisbury Craigs, the effect produced being, though on a small scale, remarkably similar. Below this bed of trap and sandstone, a compact bed of sandstone occurs. The trap, where in contact with it, having a brown and contorted appearance. It is certainly a remarkable circumstance that, notwithstanding these beds of trap are intimately connected and interstratified with the coal measures, no injurious effect on the coal of this field appears to have been caused by them, and that no blind coal has been found, notwithstanding the indurating effect which is seen to be produced upon the strata in contact with these beds as seen at Borrowstownness distillery.

The trap of the Bathgate Hills rises to a considerable height at the Riccarton Hills; and at the eastern extremity of the Bathgate Hills, at Binny Craig, the trap breaks up to the west in a very remarkable manner. This hill is 711 feet above the level of the sea;* and connected with the trap of these hills is that of Dechmont Law, which is 686 feet above the level of the sea, and of Torhill, of small extent. In regard to the connexion of the traprock with the coal measures to the east of this point, little can be added to what has already been stated, as to the manner in which the minerals occur in that part of the country, the coal measures being there so much broken up and intermingled with these

* These heights are stated by Mr Knox in his map of the basin of the Forth, and are very correct. We measured several of them by the barometer.

igneous rocks; and, as it is only by tracing the strata in the beds of the river Almond and on the sea-shore that their position can be examined towards this extremity of the county, where it becomes very narrow, and is almost entirely composed of trap-rocks, which occupy the middle of it, and rise into eminences of no great height at Craigton Hill, Craigy Hill, Mons Hill, &c.

On the banks of the canal, a short way south from Winchburgh Bridge, a number of wavings occur in beds of sandstone, and a trap-dyke is seen traversing these beds and altering the position of the strata, as seen on the west side of the canal. This dyke, as pointed out by Mr Cunningham in his essay on the geology of the Lothians, breaks, on the east bank of the canal, into two, at its upper extremity, where slate intervenes, and where it throws the sandstone beds on each side into nearly a vertical position; and in a quarry on the road-side near Murrayhall, as also pointed out by Mr Cunningham, beds of sandstone highly indurated are seen at right angles to their inclination.

The only other place towards the eastern extremity of the county where a local peculiarity in any way remarkable has been observed to occur is at Hound Point, in the parish of Dalmeny, where the lower part of a large greenstone dyke is found in contact with a bed of slate-clay, below which there is a bed of felspar overlying sandstone; the sandstone is at some parts enveloped in the felspar, and the bed of slate-clay, which contains a good deal of iron, is highly indurated, and a good deal broken up by small fissures at right angles to the bed.

The conclusion to be drawn from the facts here stated as to the circumstances attending the original formation of these stratified and unstratified rocks are, that after these rocks had been deposited, some great convulsion of nature had destroyed their regular arrangement, partly by the influence of the igneous rocks connected with them, and upon which they appear to have been superimposed; and that after this great convulsion the whole mass of these stratified and unstratified rocks have been subjected to the influence of powerful currents of water, which have passed over them apparently in a direction running from east to west. But whether we are to hold that all the circumstances connected with the position of these rocks, and the deposits superimposed upon them, are to be accounted for to the full extent by the causes to which they have been attributed by many geologists, may perhaps be considered as in some degree doubtful; for it is certainly, at least, a phenomenon somewhat remarkable, if all the variety of occurrences which are observed in connexion with aqueous and igneous rocks, are to be attributed entirely, or nearly so, to an irruptive or upward movement; for if we are to hold this to be the case, then we must also hold that this

irruptive movement has not only been exerted in a local manner, and at certain great central points, but also by breaking through the strata in long lines of irruptive movement, rising through the numerous rents and fissures thereby created, whilst it appears that these occurrences may be accounted for apparently with more simplicity, and, therefore, with not less probability, by the supposition that the present relative position of these aqueous and igneous rocks has been caused by the submersion of the former amongst the latter when in a fluid state, when the supposed convulsion had taken place, which would readily account for the circumstance of igneous rocks being found in lines running in the same direction as the strata, and sometimes flowing over them. But it is not to be supposed that we therefore hold the various occurrences connected with these strata have arisen entirely from subsiding, but that many of them seem very markedly to indicate that such has been their origin, whilst, undoubtedly, certain points do occur where the irruptive power may have been exerted; and this, at the same time, fully concurs with the circumstance that the general direction of the faults in these strata is in a line with their inclination, and is, indeed, strongly supported by the evident tendency to assume the form of basins, which these strata have when in immediate contact with traprocks, and also from the waving and warped position in which they are often found, arising from the flexible nature of these beds, probably increased by their being in contact with igneous rocks in a state of fusion, which would also account for the faults being invariably of unfathomable depth, as the bending of the strata would, of course, cause these rents or fissures to originate at the bottom of the strata.

It certainly appears that the strata of this district, in assuming their present position, have been most materially affected by causes apart from those arising from the influence of igneous rocks. Indeed, it is quite apparent that in those parts of the district where the stratified rocks chiefly occur, the effect produced upon the strata, by irruptive movement, has been comparatively trifling. On examining the general position of the stratified rocks, we find that they occupy chiefly the large low-lying tract or valley, extending from north to south from the high ground in the centre of West Lothian to the Pentland range of hills. Towards the eastern part of this district they occupy a comparatively level position; but towards the west they rise to a considerable height at Longridge and the Falla Hills, (See Plate V. sec. No. 3,) to the north of which they occupy the still higher ground at Woodmuir, Muldron, and Wilsontown. It does not appear that the circumstance of their occupying these elevated positions, and to so great an extent, can be attributed to the influence of igneous

rocks, as none occur within a considerable distance. Nor does it seem to be attributable to lateral pressure. The high ground at Woodmuir, Wilsontown, &c., extends from east to west, in a line fully as high as any part of the neighbouring country—Woodmuir being more than 1000 feet above the level of the sea—and there is no particular circumstance to distinguish the strata there or at Falla Hills and Longridge from those of other parts of the district. The Shotts minerals, as was previously stated, occur somewhat in the form of a basin, and the Fauldhouse minerals, which lie below them, dip north-west at a very small angle, and at the bottom of the series to which they belong. The Wilsontown, Woodmuir, and Longford minerals, which are the next in order, and the other minerals in the low ground eastward, dip in the same general direction, which is also that in which the faults point, and do so independently of any igneous rocks whatever. It seems out of the question to attribute a general elevation, such as this, to lateral pressure.

On examining the position of the strata where in more immediate contact with the traprocks, we do not find that the strata are upraised all round these rocks, but only where they run parallel to them, as at the east and west ends of the Bathgate Hills; but when they come in contact with them in the line of their direction, that is, in their longitudinal line of bearing, as on the north and south sides of these hills, they are scarcely perceptibly affected. Undoubtedly the coal measures, where in contact with the trap at the eastern part of the county, are found much broken up; but the strata on either side of it retain their usual direction, the dip sometimes changing from north-west to south-east. The strata also in many instances retain their usual direction even when included amongst the great mass of the traprocks, as in the case of the great main post of carboniferous limestone which crosses diagonally through the Bathgate Hills from south-west to north-east, and the coal at Cathlaw and at Kipps. Nor does there appear to be any reas n why many, and, indeed, most of the circumstances observed in regard to their contact, may not be accounted for as satisfactorily by the supposition of the strata having subsided as by any other hypothesis, or why many of the circumstances connected with these igneous rocks themselves may not have arisen from a similar cause. That the unstratified rocks are of igneous origin there can now be no doubt in the mind of any one at all conversant with the subject; but, at the same time, they may owe their elevation, in a considerable degree, to the force created by the general sinking of the stratified among the unstratified rocks, when the latter were either totally or partly in a state of fusion. Indeed there are a number of circumstances

connected with this district which give the strongest proof of the important effect produced by the sinking of the strata—as the trap-dyke which crosses the lower ground, forming the valleys of the Breich and Almond, and scarcely rising above the surface—the trap being found interstratified with the coal measures at Borrowstownness, plainly injected by the strata sinking down among the melted mass of trap beneath; and the circumstance of the direction of the dip of the strata being changed from north-west to south-east in a line crossing the Almond and Breich near their junction—a locality totally unconnected with traprocks—a change which subsiding could alone have caused.

If any conclusion whatever can be drawn from the direction of the faults in the strata of this district, it is this, that their prevailing direction is in a line with the dip and rise of the strata, and that their direction appears to depend upon no other circumstance. If their formation were attributable to the irruption of the trap hills, it is evident that they would originate at, and run from, the point where the force was exerted, but their prevailing direction is not towards the trap hills. Thus, near the west end of the county at Boarbachlaw, and on the south of Colinsheil, the faults run in various directions, usually towards the dip, which is there changed towards the north-east, and do not generally point towards the trap near them on the north-west. The large fault which runs on the north side of Boghead and Hardhill collieries does not point towards the Bathgate Hills, which are at no great distance, but towards the north-west, *i. e.* nearly parallel to them at their nearest point. In the Borrowstownness coal-field, which is quite in contact with the trap of the high ground between Borrowstownness and Linlithgow, the strata are not inclined towards the trap, but nearly at right angles to it, and the faults run in the line of the dip. But, on the contrary, as appears from the direction of the level of the Grange old engine-pit, the strata seem to rise towards the north, that is, towards the river Forth, where there are apparently no traprocks, and near that place there are faults running towards the north, plainly indicating a sinking of the strata on the side of the field farthest from the great body of the traprocks. The faults in the strata at Fauldhouse, may, indeed, be said to point, in some degree, towards the trap near Shotts kirk, which is at a considerable distance, but the great faults in the Shotts field do not point towards it.

It does not appear that any special inference can be drawn from the circumstance of the faults being generally up or down to one side more than another, as that may, it would seem, be attributed either to an upward or downward motion, or to a combination of both. It sometimes, though not invariably, happens that the faults in

this district are up or down on the side towards which the surface of the country ascends or descends, as at Borrowstownness coal-field, where the surface descends towards the river Forth on the north, and the faults are chiefly down to that side; and, as was previously stated with regard to that coal-field, where there is a change on the surface, it is usually also perceived below, as at the rise of the ground immediately to the south of Borrowstownness, where the dip increases from 1 foot in 8 to 1 in 5. But such is not the general rule with regard to the faults in the strata in the other parts of the district, for the reverse is rather the case in some instances, at Bonhar and Fauldhouse. They, in general, vary indiscriminately on one side or the other, and, in one remarkable instance, at Kinglass, a large fault, which towards the dip is down to the south, becomes down to the north towards the rise.

It is certainly a remarkable circumstance with regard to the strata of the coal formation of the Lothians and of Fifeshire, that they almost invariably extend longitudinally from north-east to south-west, and that, as appears from the published accounts of these strata, the general direction of the faults in them is from south-east to north-west. Thus, it will be observed from Mr Milne's excellent and comprehensive memoir on the Mid-Lothian and East Lothian coal-fields, that the faults run from south-east to north-west. Mr Landale, in his excellent Report on the East of Fife coal-field, states that, "While they (the faults) exhibit waving lines and cross shoots, they have all a general line of bearing, and a degree of parallelism. On the west side of the basin they point usually to the Bass Rock and on the east to the Island of May." Thus assuming a similar direction, though more directly from east to west; and, it appears from the very correct report on the Dunfermline coal-field, by the Rev. Mr Chalmers, that, although the direction of the dip of the strata in that coal-field varies considerably, the general direction of the faults is from south-east to north-west. It may also be remarked with regard to the districts now alluded to, that where there is a general inclination of the country on the opposite sides of the Forth, as at the Mid-Lothian and East Lothian coal-field, and the East of Fife coal-field, and the Borrowstownness and Dunfermline coal-fields, the faults are chiefly down on the sides nearest the south, a circumstance which may be attributed with apparently as much justice to the sinking down of the intermediate space as to a general rising of the country around. Mr Landale attributes the position of the stratified rocks in the east of Fife in a considerable degree to the traprocks of that district; and Mr Milne states some highly interesting views regarding the circumstances by which the stratified rocks of Mid-

Lothian and East Lothian may have been affected, which he attributes to the combined effects of the uprising or outbursting of the igneous rocks, the lateral pressure thereby produced, and the sinking of the strata in consequence of the hollow produced below them. While I am fully aware of the value of these views, and of the important effects which may have arisen from such causes, I certainly consider that the preponderating effect has been produced by a general sinking of the strata.

With regard to the effect produced by the currents by which the diluvial deposits have been formed, although these have undoubtedly been extensive and powerful, still it does not appear that in this district very important effects have been caused by them upon the subjacent rocks, although certainly sufficient to shew the direction of these currents, as the traprocks in many instances breaking up to the west, and shewing lines of groovings along the top of their mural faces, as at Riccarton Hills, Binny Craig, &c. But this is by no means of universal occurrence, as, in many instances, the hills have a regular and rounded appearance, and are surrounded on all sides by diluvial deposits of considerable depth.

The general position of the coal-fields and other minerals in the county will be seen from the general sections and the section of Borrowstownness coal-field lodged with this essay. The general sections are intended to be as nearly as possible on the scale of the county map, and shew the general contours of the hills in or near the lines through which they are taken.*

It is very difficult to form even an approximation to the amount of coal, ironstone, and other valuable minerals existing in this county. That there is a vast amount of these minerals still existing in it is undoubted. It may, therefore, be viewed as a mineral district of very considerable importance. And more especially if it shall be opened up by the railways which are contemplated—namely, the Shott's and Wilsontown Railway—to Breich toll; branches from one of the principal railways to the south of the Bathgate Hills; and the railway from Edinburgh to London, which it is proposed shall be brought to the north of the Pentland Hills towards Carnwath. The ironstone is very abundant, and might be used to great advantage, not only by means of the adjacent coal and limestone, but also by being carried to a distance to be manufactured elsewhere.

Considerable attention has been paid to the topography of the district, and the map used by the directions of the Highland and Agricultural Society has been generally found correct. There

* A number of plans of the principal mines, sections and journals of strata, and sections of special localities, &c., have accompanied this essay, but which our space will not admit of.—ED.

are several instances in which new roads, alterations in the line of roads, and recent buildings, are not shewn, but the greater part of these have probably been made since the survey for the map took place. There are also a few errors as to the names of places, as Auchen Bard for Auchen Hard, Birkenhead for Boghead, Mound Point for Hound Point, &c., but these are of very trifling importance. There is a map by Forest, which is on a much larger scale, and exceedingly correct, but not of very recent date.

There is one subject of a very interesting nature, of which nothing has as yet been said in this essay—namely, the organic remains which occur in the various strata. There are an immense variety of fossil organic remains contained in the strata of this district, some of which belong to very rare species. But it has been totally out of my power to devote to it by any means so much attention as it undoubtedly deserves; for it is, indeed, sufficient to form a study by itself, and requires a considerable space of time before a collection of specimens can be made in the course of the quarrying and mining operations.

The organic remains of this district chiefly occur in sandstone, shale, slate-clay, limestone, and ironstone. Vegetable remains occur chiefly in the sandstone, and are, so far as I have yet found, of rather rare occurrence in limestone. The vegetable remains found in sandstone are usually composed of very finely grained sandstone, coated with a small portion of coaly matter; and when impressions only occur, they are composed of coaly matter alone; and in some instances an impure sort of iron is found coating the sandstone, and apparently supplying the place of the coaly matter. Shells abound in shale and slate-clay, in which they are often found in a state of great perfection. But in the softer varieties of slate-clay they are generally very fragile, or mere impressions. The fossils in the carboniferous limestone of this district occur in immense quantity, and in a very perfect state.

ON THE RADICAL EXCRETION OF PLANTS.

By Alfred Gyde, Esq., M.R.C.S.E., Painswick.

[Premium—Twenty Sovereigns.]

At the present time, some of our most celebrated vegetable physiologists differ in opinion with respect to the offices performed by the roots of plants. Independently of the ordinary functions of the roots, viz., the absorption of water and saline

matters from the soil, some physiologists, and with them the late celebrated Professor of Botany, M. de Candolle, believe that plants possess the property of excreting, by their roots substances which are formed in their texture, and which, if retained in them, would be injurious to their healthy growth and developement; this excreted matter is also supposed by them to exert a poisonous influence when absorbed by plants of the same order as those from which the excretions were discharged; but that, when plants of a different order are grown in succession, the matter excreted by the roots of one plant becomes a source of food to the following.

Hence, they believe, arises the degeneration in quantity and quality of any crop when cultivated for several years in succession on the same land; and hence, also, they explain the cause of the luxuriance of crops when plants belonging to different natural orders are cultivated in succession, as in planting wheat after clover, supposing the excretions from the clover roots to be conducive to the growth of the wheat plant.

M. de Candolle, with whom this theory first had its origin, conceived it probable that plants excreted matter from their roots, from M. Brugman's having observed drops of liquid exude from the roots of some plants which he had placed in dry sand, and also from the knowledge that the roots of some classes of plants give off a powerful odour when exposed—of such are the euphorbias and mimosas. These facts, with some others, led him to form his theory of the rotation of crops, which he promulgated in his lectures and in his "Vegetable Physiology."* He believes that "every plant, in ejecting all the moisture that extends to the roots, cannot fail to eject also such particles as do not contribute to nourishment. Thus, when the sap has been spread by circulation thoughout the vegetable, elaborated and deprived of a great quantity of water by the leaves, and then redescending, has furnished to the organs all the nourishment it contained, there must be a residence of particles which cannot assimilate with the vegetable, being improper for its nourishment. M. de Candolle asserts "that these particles, after having traversed the whole system without alteration, return to the earth by the roots, and thus render it less proper to sustain a second crop of the same family of vegetables, by accumulating soluble substances they cannot assimilate with it." In like manner he observes "that no animal whatever can be sustained by its own excrement." These opinions of M. de Candolle received a degree of confirmation from the experiments on the roots of plants made by M. Macaire, who, after removing plants from the soil and well wash-

* Published in 1827.

ing their roots, placed them in vials containing rain water, and after a time he observed that the water contained evidence of exudation from them. He states that vigorous plants of *Chandrilla muralis*, when their roots are placed in water, vegetate and bloom freely. Some of these plants, therefore, were selected by him for experiment, removed from the soil, and their roots placed in water, the plants being replaced by fresh ones every two days. After eight days the water in which these plants vegetated had acquired a yellow tint and strong odour, which much resembled that of opium; it had also a bitter and rather pungent taste—when added to solution of acetate and sub-acetate of lead, it precipitated in small brown flakes; a solution of gelatine was rendered turbid by it; and, when a portion of the water was evaporated, a brown reddish colouring matter was deposited. Similar experiments were made with other plants, and with nearly the same results. He also endeavoured to ascertain at what period of the day or night excretion was most abundantly given off by plants. To attain this information, he placed the roots of kidney-bean plants in water, contained in one vessel during the day, and removed them into another vessel containing water during the night, and he observed that the greatest quantity of excretion occurred during the day-time. Plants were also made to take up by their roots saline and metallic salts in solution in water; after a given time they were removed, well washed, and were placed in pure water, which, at the expiration of two days, was examined and found to contain traces of the salts previously absorbed. From these and similar experiments he concludes "that most vegetables exude, by their roots, substances injurious to vegetation; 2dly, That the nature of these substances varies according to the families of the vegetables that produce them; 3dly, That some, being pungent and resinous, may hurt, and others, being sweet and gummy, may contribute to the nourishment of other vegetables; 4thly, That *these facts tend to confirm the theory of the rotation of crops suggested by M. de Candolle.*" These statements of M. Macaire have been met by counter-statements by M. Braconnot, who admits the existence of organic matter in water in which the roots of some plants are immersed, but attributes it to rupture of their roots, it being very difficult to remove them from the soil without injury. He also washed the soil in which the poppy and some other plants had grown for several successive years, but, besides a solution of saline and earthy matters, he only obtained traces of orgânic matter, and concludes that, "if organic excretions really take place in the natural state of the plant, they are, as yet, so obscure and little known as to justify the

presumption that some other explanation must be given of the general system of rotation."

Other physiologists altogether deny the power of excretion by the roots, and with these are M. Mirbel, who, in speaking of the theory of the excretion of plants, says "that such excretions he (M. de Candolle) supposes to be emanations from the roots—the remains of those juices which the earth and air conjointly supply, and upon which in reality the plant exists. But against even the very fact mentioned by De Candolle, in confirmation of his opinion, that opium, strewed upon the ground, kills plants, and renders the soil henceforth unproductive, we may quote the much more apposite fact, that trees (why not, therefore, *a fortiori* corn and grasses) grow and flourish for entire centuries in the midst of excretions from their roots."—"Plants require other elements for their support besides those of assimilation, and never thrive without them; for instance, there is silex in the cane, and there is lime in certain plants whose organization could not be complete without it. The quantity of any such ingredient in a plant is generally very small; but the necessity for it may be presumed absolute. Plants cannot be constituted unless all they require be furnished to them; and, indeed, the same observation will apply to animals:—Deprive a hen of lime, and her egg will have no shell—deprive animals of salt, and you will ruin their powers of digestion." With such conflicting opinions, promulgated by men of such celebrity as M. de Candolle and M. Mirbel, and the influence which clear and definite information on this subject must exert on the establishment of a correct theory of the rotation of crops, it becomes a matter of importance that the subject be fully and fairly investigated, and that the true functions of the roots of plants be clearly defined. Impressed with this idea, the author, in the year 1842, first commenced the investigation of this interesting subject, and his experiments have been continued to the present time; the mode of conducting the experiments, and the results which he has arrived at, he now begs leave to submit to the Highland and Agricultural Society of Scotland for their consideration.

1*st*, The inquiry or questions which suggested themselves were as follows:—Do plants, or do they not, during their healthy growth, excrete matter from their roots?

If they excrete, is the matter excreted organic or is it inorganic?

If organic, of what does it consist?

If inorganic, what is its composition?

Does the matter excreted by different classes of plants possess properties peculiar to each class?

If so, what is the peculiar property of each?

Is it identical with the sap of the plant, or does it differ?

What is the physiological action of the roots of plants by which excretion takes place?

Have plants the power of excreting, by their roots, substances previously absorbed, and which are noxious to them?

Will germination occur, and the growth of plants proceed, after the seeds have been impregnated with noxious matters?

Will seeds germinate and grow in poisoned soils?

Why do plants refuse to grow on some soils, while they grow freely on others?

From the difficulty and uncertainty of removing the roots of plants from the soil, when grown under ordinary circumstances, without injury to the extremities of their fibres, it was found necessary to have recourse to such a mode of growing them that they could have their roots freed from the soil, at any period of their growth, without sustaining injury—this object was attained by growing plants in the following manner:—

1st, In garden soil placed in pots, and plunged in the earth.

2d, In pots filled with siliceous sand, the growth of the plants being promoted by waterings with weak liquid manure, *i. e.*, dunghill drainings mixed with water, and allowed to become clear before using it.

3d, In pots filled with siliceous sand, which had been repeatedly washed with boiling water.

4th, In pots filled with damp moss.

5th, In pots filled with coarsely powdered charcoal.

The plants thus grown were wheat, barley, oats, rye, beans, pease, vetches, kidney-beans, (two varieties,) cabbages, mustard, and turnips.

In order to answer the 1st inquiry, "Do plants, or do they not, during their healthy growth, excrete matter from their roots?"—plants of the above kinds were operated upon at different periods of their growth. The experiments were conducted in the following manner:—The roots of the plants, after being removed from the pots in which they had grown, were thoroughly washed by the action of a gentle stream of water, and after being carefully dried on folds of filtering paper, were placed in glasses containing distilled water, which had been exposed to the atmosphere for some days. In this situation the roots were carefully excluded from the light, and kept at as uniform a temperature of about 55° as practicable, the green portions of the plant being fully exposed to the action of light

and air, the water in the vessels being renewed as it diminished, from absorption by the plant and evaporation from the surface.

TABLE I.—*Experiments on the Order Leguminosæ.*

Plant of	Grown in	Number operated on	State of Growth of Plants	State of Health of Plants	Time Plants retained their healthy appearance	Colour of Water holding Excretion in solution	Odour of Water	Colour of dry Excretion
Beans.	Soil	4	1 foot high	good	Days 8		slight	light brown
	Sand No 2*	5	2 feet ,,	good, shewing bloom	10	straw	,,	brown
	,,	5	1 foot ,,	feeble	10		very slight	pale brown
	Soil	5	3 feet ,,	vigorous, seed forming	14	straw	slight	brown
	Sand No. 1	5	2 feet 6 in	good, in bloom	6	,,	,,	pale brown
	Soil	4	3 feet high	good, bloom	6		,,	brown
Pease.	Soil	5	8 inches	good	12			yellow
	,,	5	in bloom	,,	6		very slight	deep yellow
	,,	5	seed formed	,,	10		,,	yellow
	Sand No. 1	5	young	,,	10			,,
	,,	5	shewing bloom	,,	7			,,
	No. 2	5	1 foot high	feeble	10			,,
Vetches.	Soil	10	,,	vigorous	10			traces yellow
	,,	10	bloom	,,	8			,,
	,,	10	seed perfect	,,	10			slight traces
	Sand No 1	5	young	,,	6			yellow ,,
	,,	5	bloom	,,	10			,,
Kidney Beans.	Soil	3	young	,,	4		slight	pale yellow
	,,	4	bloom	,,	3		,,	yellow
	Sand No. 1	5	young	good	5			pale yellow
	,,	5	bloom	,,	3			yellow

* The numbers refer to the mode in which the plants were grown.

Table II.—*Experiments on the Order Gramineæ.*

Plant of	Grown in	Number operated on	State of Growth of Plants.	State of Health of Plants	Time Plants retained their healthy appearance	Colour of Water holding Excret on in solution	Odour of Water	Colour of dry Excretion.
Wheat (Varieties.)	Soil	5	8 inches	good	Days 12	none	none	pale straw
	"	5	shewing bloom	"	10	"	"	only traces straw
	"	25	seed ripening	"	12	"	"	straw
	Sand No. 1	5	8 inches	"	15	"	"	straw traces
	"	15	shewing bloom	good, but small	12	"	"	"
	Sand No 2	5	10 inches	feeble	7	"	"	"
Barley.	Soil	7	6 inches	good	15	"	"	pale straw
	"	5	bloom	"	10	"	"	"
	"	26	seed forming	"	17	"	"	"
	Sand No. 1	5	shewing ear	"	10	"	"	traces
	Soil	5	bloom	"	10	"	"	"
Oats.	Soil	5	young	"	10	"	"	pale straw traces
	"	10	bloom	"	8	"	"	
	Sand No. 1	5	shewing ear	"	10	"	"	"
	Soil rich.	2	bloom	vigorous	10	"	"	"
Rye.	Soil	5	young	good	10	"	"	"
	Sand	10	bloom	"	10	"	"	"

Table III.—*Experiments on the Order Cruciferæ.*

Plant of	Grown in	Number operated on	State of Growth of Plants.	State of Health of Plants.	Time Plants retained their healthy appearance in water	Colour of Water holding Excretion in Solution	Odour of Water holding Excretion in Solution.	Colour of dry Excretion
Cabbage.	Soil	2	young	good	Days 3	none	rather strong of the cabbage	very pale yellow
	"	2	half-grown	"	4	"	"	"
	Sand	1	young	"	4	"	slight	traces
	Soil	2	past bloom	"	5	"	rather strong	"
Mustard.	Soil	50	young	"	5	"	slight	pale and slight
	"	40	half-grown	"	6	"	"	slight
	Sand	50	young	"	6	"	"	"
Turnip	Soil	5	young	"	5	"	"	very slight
	"	5	bulb forming	"	3	"	like cabbage	pale
	"	5	half-grown	"	3	"	"	"
	Sand	3	"	"	5	"	"	"

From the above experiments it will be seen that the roots of plants impart to water a portion of soluble matter or excretion, and that this excretion appears to be yielded in greater abundance by plants having large and spongy extremities to their roots, as beans, than by those plants possessed of fine thread-like extremities, as is the case with wheat or cabbages. It will also be observed that, in some instances, the water has acquired an odour which is separable on the application of heat, and may be distilled over when the water is placed in a retort; the plants which impart odour to water, as the bean and cabbage, are also characterized by emitting a similar odour from their leaves. Plants when in bloom were observed to emit a larger portion of excretion than when young or when ripening their seeds; but the amount of excretion obtained, even when many plants were operated upon, was very trifling, seldom being more than a grain in weight when dry.

Of the excretion obtained from the leguminous plants, a portion became insoluble during the evaporation of the water. This result was not observed with any other orders of plants operated on. The matter rendered insoluble by heat was of a brown colour, and precipitated in flakes from the water; when dry, it was found to be insoluble in water, but soluble in weak caustic alkalis, yielding a solution of a brown colour, from which it was again precipitated on the addition of an acid. The portion which still remained soluble in water yielded a white precipitate with acetate of lead—brown with nitrate of silver—and was rendered turbid on the addition of alcohol: it evidently contained gum or mucilage. When a portion of the excreted matter was heated on platinum foil, it carbonized and emitted the odour of burning grain, and, when strongly heated, to burn off the organic portion, a trace of inorganic matter was left on the foil. In order to ascertain the character of this inorganic matter, the excretion from a number of plants was collected and heated in a small platinum dish, until the whole of the organic matter was burned off; the inorganic matter was then moistened with a few drops of distilled water, which dissolved a portion of it. The solution was found to produce an alkaline reaction when applied to litmus paper, first slightly reddened by a very dilute acid. The insoluble portion left on the foil, when touched with a glass rod dipped in dilute hydrochloric acid, was immediately dissolved with the escape of minute bubbles of carbonic acid gas. This solution was divided into two portions on slips of glass, and to one was added a drop of chloride of barium, when the presence of a sulphate was indicated by a white cloud of sulphate of barium. To the other a drop of ammonia was added, and then a drop of oxalate of ammonia, when the presence of lime was indicated.

Similar experiments were made on excretion from plants of the order *Gramineæ* and *Cruciferæ*, and in each a portion of inorganic matter was found; the results of the examination being nearly similar to those on the excretion from plants of the order *Leguminosæ*.

In order to ascertain if the soil in which plants had grown contained any portion of excretion, the following experiment was tried:—Sand, which had been well washed with boiling water, was planted with young beans and pease; these plants were supplied with distilled water, and placed under the most favourable circumstances for healthy vegetation. After they had grown in the sand three weeks, they were removed, and the sand washed with distilled water—filtered—and, on evaporation, it yielded a portion of both organic and inorganic matter, in every respect of a similar character to that obtained by the immersion of the roots in water. Plants of the same kinds to those used in the former experiments were cut from their stems, the lower extremities of which were plunged in distilled water, so that the descending sap, which it was presumed would escape, might be examined and compared with the radical excretions from the same kinds of plants, and it was found that in each instance similar results were obtained on evaporation of the water in which the cut plants had been immersed as those from the water in which the roots of similar plants had excreted. Hence we may conclude that the matter obtained from the roots of plants, or radical excretion, is similar to the sap of the plant from which it was excreted.

The next question which presents itself is the physiological action of the roots of plants by which excretion takes place. The roots of plants are described as the downward prolongation of the stem, as the trunk and branches are the upward developement into the air—the spongioles and extremities of the roots being the newest formed and extending portions, and that by these spongioles fluids are taken up from the soil and conveyed into the circulation of the plants.

The fluids thus absorbed are carried by the vessels of the most recently formed wood to the leaves, where, after undergoing certain changes during its exposure to the action of air and light, by which much water is given off by evaporation, the elaborated sap is returned by another set of vessels situated in the inner bark of the tree to the root, supplying, during its descent, those constituents necessary for the healthy secretions of the plant.

The sap having arrived in the roots, new fluid is added to it from the soil, and the ascent again commences by the vessels of the new wood, this action continually taking place during the

life of the tree, but progressing more rapidly at one season of the year than at another.

Many and ingenious are the theories which have been formed to explain the ascent of the sap. Of these, that which was first pointed out by Detrochet appears most probable, and is now generally received by physiologists. Detrochet found that if, into a glass tube, having one end covered with animal membrane tightly secured over it, a strong solution of salt in water or sugar in water be poured, and the end covered with membrane be immersed in a vessel containing water, that in a few hours the liquid within the tube will be found to have risen several feet. This ascent of the liquid in the tube being caused by a portion of the water from the outside of the tube passing through the membrane and mixing with the solution in the tube, and at the same time a portion of the solution will be found mixed with the water outside the tube—this action continuing until both liquids become of the same specific gravity: the former of these actions Detrochet terms *endosmose*, and the latter *exosmose*, and he attributes the action to the effect of electricity.

If we allow the liquid within the tube to represent the sap of the tree—the membrane covering the tube to represent the spongioles of the roots—and the water in which the lower portion of the tube is immersed the water in the soil, we have a combination of circumstances which approach the state of the growing tree, the sap in the tree always being of greater specific gravity than the water surrounding the roots. Under these circumstances there is every probability that a similar action to the one just described is continually going on in the plant during the active period of its growth—water would be taken into the plant through the spongioles of the roots by endosmose, and a portion of the sap would escape into the soil by exosmose, the sap consisting of both organic and inorganic matter in solution in water,* and ever be of greater specific gravity than the water in the soil, arising from the exhalation of water continually going on from the leaves, and consequent concentration of the sap prior to its descent.

But to ascertain by direct experiment how far endosmose and exosmose actually occurs when the living plant is made part of the arrangement, several funnel-shaped glasses were prepared, which would hold about 3 fluid ounces of liquid each, and present $2\frac{1}{2}$ square inches of membraneous substance, through

* One gallon of beech sap taken from the tree in the month of May was found by direct experiment to contain

Organic matter dried at 212°,	. .	82 grains
Inorganic matter,	. .	22 do.

which endosmose might take place; these glasses were filled with saline solutions, and also solutions of organic matter, and plants cut from their roots immersed in them through the upper opening, where they were secured by collars of Indian rubber, the portion covered with membrane being immersed in water. In each instance the saline solutions were rapidly absorbed by the plants, they were detected in all parts of their structure, and a portion of the solutions was found to have passed by exosmose into the water in which the membrane was placed. An extract from my note-book will probably place the manner of conducting these experiments in a clear light:—

May 9. Half-past 11 A.M. Temperature in sun 80.0. Air dry, endosmose tube, with 2½ square inches of membrane (bladder) filled with half saturated solution of salt and water, in which was placed a young cabbage, cut near the soil, and exposing about 160 square inches of green leaf to the sun's rays, the stem secured by collar of Indian rubber, and the membrane placed in water.

12.30 Plant evidently drooping.

1.30 Plant drooping much.

2.0 Plant removed. Observation—Two fluid drams of the solution had been absorbed by the plant, and a portion of the salt had passed by exosmose into the water, as proved by adding nitric acid to the water, and testing with a solution of nitrate of silver, chloride of silver being precipitated.

May 9. Temperature and air as above; mounted endosmose tube as in the former experiment, but used dilute solution of bichromate of potash, and a limb cut from a black currant bush.

May 10. 9 A.M. The whole plant and greater portion of the leaves are impregnated with the bichromate of potash, and six drams of the fluid have been absorbed; exosmose has occurred, and a small portion of carbonic acid gas was found in the tube.

May 10. 10 A.M. Mounted a bean plant in bloom, with solution of prussiate of potash. 4 P.M., the whole plant impregnated with the salt; 3 drams of the liquid absorbed, exosmose had occurred, and a small quantity of carbonic acid gas had escaped from the cut extremity.

May 10. 11 A.M. In a similar manner, a branch cut from a pæony in bloom, mounted with solution of nitrate of iron in endosmose tube, 3 P.M. impregnated with the salt; leaves nearly black; exosmose has occurred, and a gas escaped as before.

May 10. 12 A.M. An endogenous stem, (the flower-stalk of the white lily,) divested of leaves, and 20 inches long, placed in endosmose tube, with solution of bichromate of potash.

May 11. 8 A.M. Stem impregnated 19 inches from the cut extremity.

But in order to imitate, as far as an experiment can be supposed to do, the circumstances under which the plant lives, I mounted, May 30th, 1 P.M., an endosmose apparatus, with sap obtained from the beech, (*Fagus sylvestris,*) and secured in the tube a limb cut from a beech tree, the lower end of the tube being immersed in distilled water. The limb retained its healthy condition nearly a week, at the expiration of which time a portion of organic and inorganic matter was found on analysis to have passed by exosmose into the water. Cut plants were placed in endosmose tubes, with saline solutions of different densities; and plants of the same kind, growing in pots of sand, had the sand well

saturated with solutions of the same salts, and it was observed that the solutions reached the leaves in nearly the same time in both instances. Two glass tubes were also filled parallel to their length, the one with cotton and the other with linen threads, forming a series of fine tubes, the sides of which were composed of a similar substance to that composing the stems of plants, the glass representing the bark. These tubes, which were each 20 inches long, were mounted in endosmose tubes, with solutions of bichromate of potash and sulphate of copper respectively. In each case endosmose rapidly occurred, which was evidently facilitated by the capillary nature of the tubes.*

That fluids are, under some circumstances, transmitted through the spongioles of plants into the soil, is placed beyond a doubt, from the following circumstance which was observed during some experiments on standing trees, made in the year 1843. Several beech trees had been prepared according to Dr Boucherie's plan, for the purpose of impregnating trees with saline and metallic solutions. This consists in making a saw-cut nearly through the tree at its base, into which the solution, by which the tree is to be impregnated by absorption, is made to flow. The experiments had been in progress for some days, when it was observed that trees growing at a distance of from 15 to 20 feet from the trees under treatment were in a drooping state, and quickly perished. This circumstance led to the tracing through the soil a root of a tree under impregnation, and carefully exposing its extremities, which were placed in a glass containing distilled water. In a few hours the water was tested for the metallic solution with which the tree was under impregnation, and it was freely detected in the water as well as in the soil which surrounded the roots. To this cause the death of the surrounding trees was, no doubt, to be attributed; their roots having absorbed the poisonous solution discharged by the roots of the tree under treatment.

The experiments for the purpose of ascertaining if plants have the power of excreting by their roots substances previously absorbed into their structure, and which are noxious to their growth, are as follows:—The plants selected for these experiments were beans, barley, wheat, and cabbages; the noxious substances introduced into their structure were in solution in water, and absorbed by the plants through their roots. They were the salts of zinc, copper, mercury, arsenic, lead, chrome, barytes, lime, strontia, magnesia, and soda; and these were used

* Layers of paper, (woody fibre,) freed from earthy and saline matter by soaking in dilute acid, and from size by warm water, enclosed between two plates of linen cloth, were found to form an excellent substitute for the animal membrane for the endosmose tube.

of strengths varying from five grains of the salt dissolved in one fluid ounce of distilled water, to one grain dissolved in two fluid ounces of water. The plants operated upon were in good health, growing in soil, and also on some plants growing in damp moss and sand, as well as plants freed from soil, and their roots plunged in the solutions.

Without further detail of the experiments, the following table will explain the results:—

	Salts used.	Plants.	Grown in	State of Growth.	Effects on.
Zinc.	chloride	beans	moss	half-grown	quickly destroyed
	sulphate	cabbages wheat	soil "	young in bloom	
Copper.	sulphate	beans	"	half-grown	
	nitrate	"	moss	in bloom	
	acetates	cabbages	soil	young	
Mercury.	bichloride	beans wheat cabbages	" " "	" in bloom young	
Arsenic.	arsenious acid	cabbages and wheat	" "	" in bloom	weak solutions did not destroy the plants.
	arseniate of potash	barley cabbages	" "	" young	
Lead.	acetate	beans	"	"	destroyed after a few days.
Chrome.	bichromate of potash	cabbages beans barley	" " "	" in bloom "	destroyed except when very much diluted.
Iron.	nitrate	beans	"	bloom	destroyed after some days.
	sulphate	"	"	"	
Barium and Barytes.	chloride	beans	moss	"	quickly destroyed
	nitrate	cabbages and wheat	soil "	" "	
Strontia.	nitrate	beans	moss	"	plants unimpaired unless too strong a solution was used
Lime.	muriate	"	"	"	beans were improved when very diluted
	sulphate	"	soil	"	
	nitrate	"	moss	"	
Magnesia.	sulphate	beans and cabbages	moss	"	health impaired and if strong, destroyed
	muriate		moss & soil		
Soda and Sodium.	phosphate	"	sand	before bloom	no injurious action when diluted
	chloride	beans	& soil	and in bloom	

In conducting the above experiments, it was observed that the plants, after absorbing the solutions, in most instances either decomposed, or so combined with them, that the salt was in a great measure separated from the water which held it in solution, arising from the affinity between the metallic salts and the woody fibre of the plant. The decomposition of many metallic salts would also be effected by the organic and inorganic constituents of the plants when introduced into their structure in a very diluted state; an instance of which was seen in an oak tree that had grown for years near a stream of water occasionally impregnated with sulphate of iron. On felling the tree, the wood was found to be black as ebony, the gallic acid of the oak having decomposed the sulphate of iron introduced by the roots into the texture of the tree, and formed the colouring matter of the wood.*

Of the metallic salts, those of arsenic and chrome were least destructive to plants. These salts were accordingly introduced through the soil into plants of barley and cabbages, by administering homœopathic doses of arseniate of potash and bichromate of potash, in solution in water. After ten days of such treatment, the arsenic and chrome could be detected by analysis in the structure of the plants. At this time the plants were evidently less healthy than those growing near them; they were now carefully lifted from the soil, their roots well cleansed with water, and replanted in a soil free from any noxious matter, and, after some days of careful watering and shading from the sun, some of the plants recovered and grew. At the expiration of one month from the time the plants had been transplanted, they were removed from the soil and analysed, the result of which was, that the plants were still found to contain traces of arsenic and chrome.

The soil in which the plants had grown, after they were transplanted, was also submitted to chemical examination, but no trace of either salt could be detected.

Plants of beans† which were shewing bloom, had their roots placed in solutions of nitrate of strontia, chloride and nitrate of lime, and phosphate of soda.

The plant grew freely, and removed from the water much of the saline matter. After five days remaining in the respective solutions, they were removed, their roots well washed, and then placed in distilled water. At the expiration of five days from

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* The same result will be produced when oak saw-dust is mixed with a solution of iron.

† Beans were generally selected to try the power of excretion, since they yield the largest amount of excretion to water, and have large and spongy roots, which, if injured, would not pass unobserved.

their being placed in water, it was examined for the salts the plants had absorbed, to ascertain if any had been excreted into the water, and traces could be detected after concentration of the water by evaporation—organic matter existed as usual.

To ascertain how far plants have the power of excreting by one set of roots matters absorbed by another, the following experiments were made:—Young bean plants, grown in sand, had their roots cleansed and divided into two portions; two test-tubes were also placed by the side of each other, the one filled with distilled water and the other with a very dilute solution of bichromate of potash: into each tube one portion of the roots was placed, and the plant allowed to vegetate for four days; at the expiration of which time the water was examined for the chromate, but no trace of it could be detected. Solution of acetate of lead was substituted for the chromate, and other bean plants introduced, but the result was the same as in the former experiment. Seeds of wheat, barley, and pease, were steeped for thirty-six hours in the following solutions:—

Steeps	No. 1.—5 grains of arseniate of potash to	one ounce	of water.
...	do. of bichromate of potash to	do.	do.
	No. 2.—2 grains of arseniate of potash to	do.	do.
	do. of bichromate of potash to	do.	do.
	No. 3.—1 grain of arseniate of potash to	do.	do.
	do. of bichromate of potash to	do.	do.

The seeds, after being removed from the steep, were planted in a garden soil. Those impregnated with steep No. 1 all perished; part of the seeds from No. 2 vegetated feebly, but afterwards perished; the seeds from steep No. 3 vegetated well. These plants, after growing to the height of one foot, were taken up, washed, dried, and examined for the salts with which the seeds had been impregnated, and traces were detected.

Seeds were also planted in soils mixed with arsenious acid and chromate of potash, for the purpose of ascertaining if the plants would grow in poisoned soils, but by far the larger portion of the seeds perished before the plants made their appearance above the soil; the remainder appeared very unhealthy, and perished before the first leaves were fairly developed.

In order to ascertain the effects of excretion when applied to the roots of plants, the following experiment was made. Ten bean plants were selected and watered once every week from the time they were six inches high, until ripening the seed, with water holding excretion from beans in solution. Ten other bean plants, in every respect similar, were watered during the same period, and in the same manner, with water in which bean plants had been bruised and macerated, while ten more bean plants were watered with rain-water in the same quantities, and

at the same time as in the two former experiments, the state of growth and health of the whole number of plants was compared once every week until the plants were fully ripe, and if either set of plants were inferior to the others it was the ten to which rain-water had been applied. That the produce of the wheat crop, both in quantity and quality, is *not impaired* by excretion when grown year by year in the same soil must be admitted by every person conversant with the manner in which wheat was formerly, and is now too often, cultivated in the northern states of America; but the following statement of the produce obtained from one acre of land, sown with wheat year after year since the year 1832 to the present time, will be sufficient proof that the excretion from the roots have not exerted any very injurious action on the crop. The piece of land on which the experiment was made, and is still in progress, is situated in the county of Gloucester. It was dug in 1832, burned and sown with wheat, since which time it has received an occasional light dressing of manure, the stubble generally being burned, and the ashes spread on the land.

The produce of the acre is as follows:—

			Bushels.	Gallons.	Quarts.
Produced in	1833,	best corn,	50	1	0
Do.	1834,	do.	34	1	3
Do.	1835,	do.	49	1	6
Do.	1836,	do.	37	2	2
Do.	1837,	do.	20	3	6
Do.	1838,	do.	21	2	5
Do.	1839,	do.	27	3	6
Do.	1840,	do.	30	2	7
Do.	1841,	do.	26	2	1
Do.	1842,	do.	21	0	1
Do.	1843,	do.	37	1	4
Do.	1844,	do.	32	0	4

The crop of the year 1845 has not yet been thrashed out, but, as far as an opinion can be formed by inspection, it is not inferior to any former year's crop.

We have seen, in the preceding experiments, that plants are *not injured* by the application of excrementary matter to their roots. Why, then, is it necessary, under ordinary circumstances, to grow plants in rotation, in order to prevent their degeneration? The answer to such a question will be found in an inquiry into the composition of plants. If we submit to a chemical examination any perfect plant, we find the elements of which it consists may be referred to two distinct classes of matter: the one which is capable of dispersion by heat, and constitutes the organic portion; the other fixed and incapable of destruction by fire. The former of these, the organic portion, consists of oxygen, hydrogen, and carbon, and a small quantity of nitrogen,

—these are obtained from the atmosphere, from water, and from salts of ammonia and nitric acid. The latter, or inorganic portion, usually constitutes but a small per-centage of the entire plant, and consists of earths, alkalis, and metallic oxides, which, from their situation in the texture of the plant, assist in giving firmness and stability to the vegetable structure, and, probably, perform important offices in the vegetable but yet imperfectly understood. These substances are obtained from the soil, and are conveyed into the structure of the plant by the agency of water.

The inorganic portion of one class of plants is found, on analysis, to differ widely in composition from that of plants of a different natural order, so much so, that the commonly cultivated plants may be classified, according to their mineral constituents, thus—We find that wheat, barley, oat, and rye plants, abound in silex, but contain little lime and magnesia; that tobacco, pease, sainfoin, bean, and clover plants, contain large proportions of the salts of lime and magnesia, and only a little silex; whilst a third class of plants contain potash as their principal inorganic constituent, and are comparatively deficient in the salts of lime, silex, and magnesia—of these turnip, beet, and potato plants, are those most commonly cultivated. The necessity of these salts to constitute healthy plants may be considered absolute, since we always find them present in their structure. Hence, we may conclude that, whichever class of plants are to be cultivated, the inorganic constituents required by them must be present in the soil, and must also be in such a state that they may be taken up into the structure of the plant, or healthy vegetation cannot be maintained. Of these constituents, the most important are potash, soda, lime, magnesia, phosphoric acid, sulphuric acid, and chlorine. These substances, under most circumstances, are found to be present only in very minute quantities, even in fertile soils, yet they all exist in appreciable quantities in soils capable of producing healthy and vigorous plants. On the contrary, such soils as are deficient in these constituents are invariably barren. The fertility of soils is influenced by several circumstances besides the presence or absence of these minute portions of earthy or saline constituents, of such are the mechanical texture, depth, the presence or absence of water, elevation above the sea's level, or the existence of such substances as are noxious to the developement of the plants it is intended to cultivate; but when no such circumstances occur to impede or impair the full performance of the functions of the roots of plants, and those substances required as food by them exist in such a state as to supply their demands, such a soil is

capable of producing any crop it is required to bear. In the newly settled states of North America, and in some of our alluvial soils, we have abundant instances of the powers of the land to produce the finest crops of corn or maize year after year, without the addition of manure, and without any apparent diminution in quantity or quality of the crop. But, under this mode of cropping, a time must arrive when the soil will cease to return its accustomed produce—when it will no longer yield to the plant a sufficiency of those earthy and saline constituents necessary for its full developement; and when this time shall have arrived, the soil can only be rendered productive by restoring, in the shape of manure, those constituents the repeated cropping has deprived it of. But soils that do not contain those constituents necessary to supply the full demands of every crop which may be planted, may yet produce one class of plants in much greater perfection than another: thus, in natural forests, we find the fir, the pine, and the beech, elect to grow on thin, dry, and sandy soils, containing lime, where the oak, ash, and elm would perish, the latter trees preferring a deep clay or loamy soil containing the alkalis, potash and soda, in greater abundance than could possibly be supplied by the soil on which the beech and pine flourish.

Soils containing lime are also characterised by the appearance of leguminous plants as weeds, such are the darnel, the vetch, and the tare—plants that are rarely seen in soils deficient in lime. The (*Erica*) heaths, on sandy soils, and the (*Equisetum*) marestails, in the marsh lands, are a marked indication of abundance of silex and deficiency of lime, while the sand-worts and saltworts indicate the presence of salt in the soil, as is seen on our sea-coasts. Hence soils so constituted would bring to the greatest perfection such crops as would appear indigenous to them from plants of the same natural order electing to grow thereon, while plants of a different natural order would scarcely find sufficient nourishment for their developement, and would produce a plant of an unhealthy character, from the fact that the plant is unable to find in the soil those inorganic substances which are absolutely necessary to supply its wants. "A soil," says Sprengel, "is often neither too heavy nor too light, neither too wet nor too dry, neither too cold nor too warm, neither too fine nor too coarse; lies neither too high nor too low, is situated in a propitious climate, is found to consist of a well-proportioned mixture of clayey and sandy particles, contains an average quantity of vegetable matter, and has the benefit of a warm aspect and favouring slope." It has all the advantages, in short, which physical condition and climate can give it, and

yet it is unproductive. And why? Because, answer chemical analyses, it is destitute of certain mineral constituents which plants require for their daily food.

From the experiments above detailed, the author draws the following conclusions:—

1st, That the commonly cultivated plants of the natural orders, gramineæ, leguminosæ, and cruciferæ, excrete by their roots soluble matters.

2d, That the excretions consist of both organic and inorganic matters.

3d, That the organic portion principally consists of oxygen, hydrogen, and carbon, existing as gum and mucilage, and in some plants also of a volatile matter, or oil, possessing the odour of the plant from which the excretion is obtained.

4th, That the inorganic matter consists of saline and earthy salts, having an alkaline reaction, and containing lime, sulphuric acid, and chlorine, with potash or soda.

5th, That the quantity of excretion thrown off by any single plant is very small, and excretion can only be satisfactorily examined when collected from a number of plants.

6th, That plants having large and spongy extremities to their roots yield more excretion than plants which have slender thread-like roots.

7th, That the excreted matter is similar in its composition and reaction with tests to the sap of the plants from which the excretion is obtained.

8th, That the probable cause of excretion from the roots of plants depends on an exosmose action which goes on simultaneously with the absorption of water and saline matter by the spongioles of the roots.

9th, That plants absorb metallic salts when in solution in water, and that they quickly die unless the solutions are very largely diluted.

10th, That the salts of barytes are equally injurious to vegetables when taken into their texture as the metallic salts, but that those of strontia, lime, magnesia, and the alkalis, do not act as poison unless the solutions are comparatively strong.

11th, That plants, after the absorption of metallic salts by their roots, excrete in some instances traces of them, but they are more generally decomposed in the structure of the plant and retained.

12th, That seeds impregnated with poisonous substances may germinate if the quantity of the poison be very minute, but in most cases the seeds perish.

13th, That plants are not injured by their excretion, being

reabsorbed into their structure, as was supposed by M. de Candolle.

14*th*, That the necessity for a rotation of crops arises from the soil in most instances being unable to supply those earthy and saline constituents required by plants.

ON THE CONSTRUCTION OF TANKS.

By Mr James Kinnmonth, Invertiel, by Kirkcaldy.

[Premium—Ten Sovereigns.]

Previous to the year 1831 the writer of this report had been strongly impressed with the great loss sustained by farmers, from allowing the drainage of stables, byres, dunghills, &c., to waste off by any natural outlet; and in the course of that year he had a small tank constructed to collect the drainage of his own farm-yard. It soon became evident that, like most other half-measures, it was quite inadequate to its object, and that more than half the liquid that might have been collected still ran to waste. The experiment, however, speedily shewed the beneficial effects which resulted from the application of liquid manure to the crops, and this determined him to have a tank formed, better proportioned to the size of his farm, and which might afford a supply, to be at command when its application was either convenient or requisite.

The experience already attained led to farther inquiry as to the best means of constructing large tanks, with such economy as the circumstances of the farmer require; and here it appeared, in the first place, that failures had occurred in consequence of projectors of tanks having adopted methods that promised *great economy* in the construction, but which eventually proved failures. In some cases the defects had arisen from the tank being incapable of retaining the liquid collected therein, while, in others, it arose from an opposite cause—the incapacity of preventing the circumjacent water from entering the tank and too much diluting the manure; hence, in place of an economical result, such tanks were rendered useless, unless a double expense was incurred to reconstruct them. It appeared also that some of those failures had been, in some measure, the result of neglecting, on the part of the constructor, the laws of hydrostatics. Thus, in the case of tanks being formed like wells—that is, their depth being considerable—in which case the counteraction necessary to resist the hydrostatic pressure becomes greatly more difficult, whether from the liquid within or from the circumjacent water pressing from

without. For this reason alone it became a fixed point, in the views of the writer, that, in all cases, there is safety in avoiding the construction of deep wells to serve as tanks.

Still further consideration of the subject led to the inquiry as to the best *form* of a tank, and this was found to involve another question—the nature of the ground and substrata in which the tank is to be formed. It is, in the first place, evident, from the case of well-tanks already stated, and from due consideration of the effects of hydrostatic pressure, that the difficulties, and even the expense of construction, especially as regards tightness, will always be diminished in proportion to the decrease in depth of the tank; and in no case should the depth exceed eight or nine feet. In most cases it will be advisable to limit this to six or seven feet, or even less, where the ground may be unfavourable.

It being essential also that tanks should be closely covered, both for safety and preserving the ammonia, it follows that arching with stone or brick, as being more durable than timber, should in all cases be resorted to; but since arching becomes more expensive as the extent of the span increases, it becomes necessary again, with a view to economy, that the width of the tank be limited to six or eight feet, and from this it follows that *capacity* must be always obtained, principally by extending the length; or, when circumstances require that a tank must be limited in its length, *capacity* may be obtained by extending the width to two or even three times the limit here prescribed, and then subdividing it into three chambers or vaults, by division walls, in which requisite openings are formed to give the effect of one reservoir. Upon these and the boundary walls, two, or three arches, as the case may be, are to be thrown, covering in the whole area. This last form of tank, while it may appear more expensive, will, in fact, be rather less so than the single one.

The actual construction of tanks will always be, in some degree, modified by the strata in which they are placed, and, from the different nature of the strata, may be divided into three kinds, viz., clay, rock, and gravel, but in each of these there will be varieties.

Tanks formed on the first kind of strata, especially on the mountain or boulder clay, will be done with little difficulty, such clay being generally highly impervious, and will require only the requisite excavation, and lining the same with walls of rubble masonry to carry the arched covering.

In the alluvial clays, in which pervious strata sometimes occur, it may be necessary to treat the construction in the same manner as will be required in the more pervious gravels and rocks, that is, by careful puddling; but there are many localities where

this variety of clay is quite impervious, and hence nothing but excavation and building are necessary.

In the second kind—rocks—the same variety of circumstances may occur; they may be perfectly dry, or they may contain springs of water. In the first case nothing more is necessary than to excavate and build; but, in the second, every precaution is required, both to prevent entrance of spring water and the escape of the manure. To puddle only, in such a situation, would be endless; for, whenever the tank might be emptied of the manure, the circumjacent water would press upward against the bottom puddle, which, if not pervious, would be broken up, and so *admit* water, and in either case the destruction of the tank must follow.

To secure a tank in such a position, the certain method is to carry a drain from the lowest point of the excavation to the nearest outlet—this being done, all danger of pressure from without is removed, and the tank may be completed with a layer of puddle all over the bottom and sides, upon and against which the rubble walls are built, with the certainty of a successful result.

In the class of gravels, artificial drainage will seldom if ever be required, there being seldom any danger of hydrostatic pressure from circumjacent water—the construction of a tank here, will therefore proceed, as last described, by puddling and building. But, should it so happen that water is found to stand in the excavation, then draining must be resorted to; for it is incompatible with the nature of such a structure that it can both *hold in* and *hold out* water; for, though the sides might stand, the bottom would ultimately be forced upward, unless recourse is had to the expensive alternative of an inverted arch of stone or brick, laid over the bottom puddle. Localities may indeed occur where such an expedient might be advisable, but such a case must be the exception and not the rule.

In the construction of tanks it should be kept steadily in view, that where puddling is *required* it becomes the essential means of rendering the work perfect; and, therefore, the greatest care should be bestowed upon it. The kind of puddling required for the purpose is what may be named dry puddle. It is well tempered pure clay brought to such a firm consistence as will just allow of any two pieces, on being pressed together, to unite into a solid mass. It is made up into irregular balls or lumps and thrown with force into its place. A succession of such balls are laid all over the bottom of the excavation to the depth of at least one foot, they are thrown down, pressed, and beaten firmly together till the whole forms one solid mass. When the stratum of bottom puddle has been sufficiently consolidated, the side walls are

founded upon the puddle with broad flat stones. The bottom puddle must extend to at least one foot in *breadth* beyond the foundation of the walls, and upon this extension the *wall* puddle is founded, being first well incorporated with that of the *bottom*, and afterwards carried up regularly with the stone walls.

The walls and arch may be built in rubble masonry as already stated, or of brick-work. Towards each end of the arch a hatchway or man-hole should be formed, for the purpose of gaining access to the tank, and for ventilation when required; but these are usually closed with a cover, and a third opening is required for the pump. The floor of a tank, puddled as here described, must be paved with rough flagstones regularly jointed, or with brick laid on edge, to prevent the waste of the puddle. It is necessary also that the floor have a small declivity towards the point where the pump is to stand.

The writer, with his experience of a small tank, and having given the subject much consideration, ultimately resolved on constructing a tank of dimensions suitable for his farm. The accompanying drawing, Plate V., shews the plan of the farm-steading and the relative position of the tank, together with the lines of drain leading thereto from the byres, stable, pigstyes, cattle-sheds, and farm-yard. It was constructed in the summer of 1839, and its dimensions are, 72 feet in length, 6½ feet wide, 8 feet deep at one end to the springing of the arched cover, and 9 feet deep at the other end where the pump is placed. The strata in which this tank was excavated, consisted, first, of 2½ feet in depth of strong clay loam, then 2 feet of decayed whinstone, the remainder of the depth being in hard fresh whinstone. The walls were built of rubble stone with lime, all round, and arched over. The rock seemed perfectly water-tight, and, as there were no springs of water, it required neither puddling nor draining. The tank is placed parallel with the road that leads into the steading, and is in close proximity to the byres from which the liquid is led to it through drains cut in the decomposed whinstone—the sides and covers being built with stone and lime. The plan exhibits also the lines in which these drains are laid from the several byres, and also from the manure-yard through which the drainage of the stable passes to the tank, as well as from sheds where cattle and pigs go promiscuously through the sheds and yard. To complete, and to obtain the fullest advantage of, the sewerage, the manure-yard is formed with a concavity, the lowest point of which is 1½ foot below the level at which the liquid is drawn off by the eye of the drain at A in the plan.

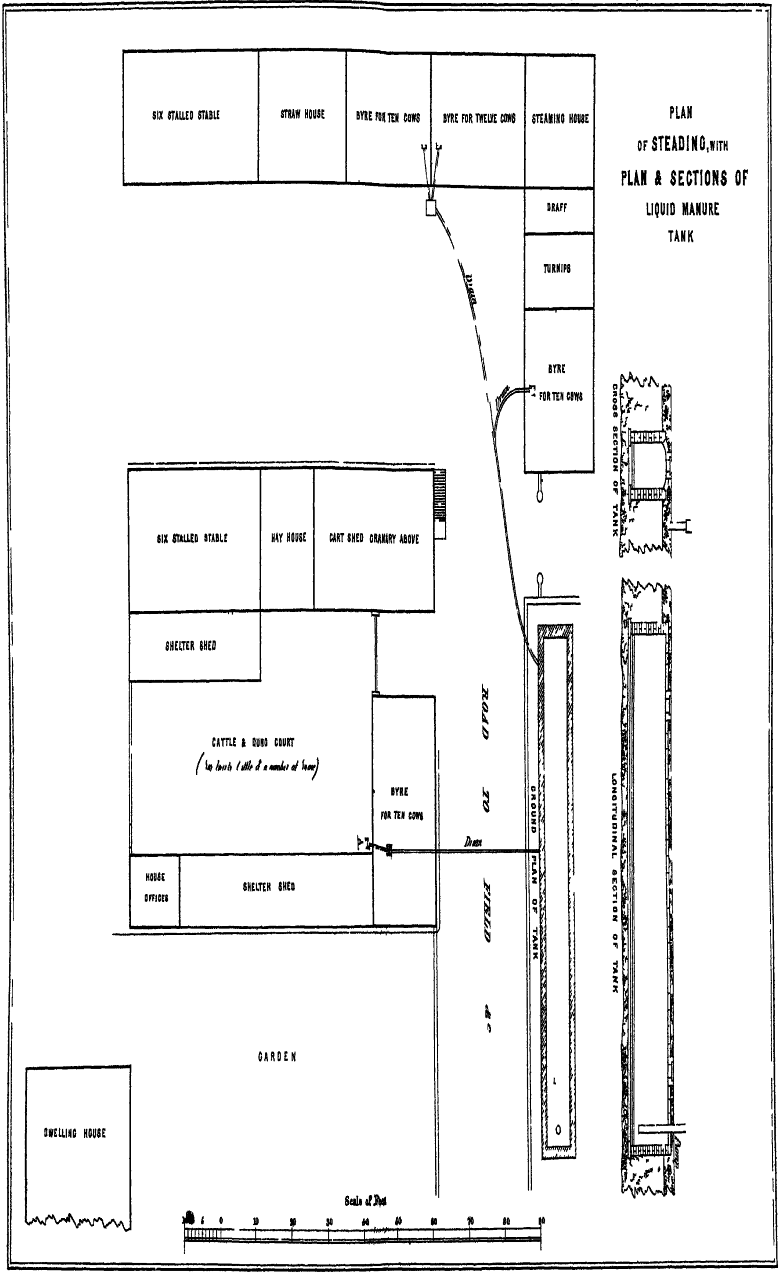
The housing around is all fitted with water rones, so that no rain falls among the manure, except directly from the clouds into the yard or when let in at pleasure.

The cutting of a tank of such dimensions, and to such a depth, may appear a work of difficulty, but it was easier accomplished than at first sight might be imagined. The rock, as already noticed, is partly a decomposed whinstone, easily removed by blasting, and the fresh parts of it afforded a sufficient quantity of rubble stone to build the walls, which are from one to two feet thick, the arch being of hammer-dressed freestone. The expense of this tank, which (all circumstances considered) may be taken as a fair average estimate of tanks of similar dimensions, consisted of the following items:—

Excavating the rock for the tank, including gunpowder and other incidents, ...	£10	0	0
Building the walls and arch, ...	9	0	0
A pump with its fittings, ...	11	0	0
Carriages performed by the horses on the farm, and which, from the circumstance of the rubble stone being got on the spot, and the arch stone also on the farm, are estimated at only	5	0	0
Total expense, ...	£35	0	0

The extent of the farm in 1831 was 125 imperial acres, and there were kept 25 to 30 milk cows stall-fed. There has since been obtained an addition of 70 acres, and there are now fed from 20 to 25 cattle, besides the 30 cows, during the greater part of the year. From experience, it has been found that even the present tank, which will contain 25,000 imperial gallons, is rather small; and it is considered that accommodation to the extent of 1000 gallons for each cow would be about sufficient. From an account regularly kept of the quantity of liquid collected in one year, it was found to amount to about 400 butts, each containing 160 imperial gallons, making an annual produce of 64,000 gallons.

Since the formation of the tank of 1831, liquid manure has been used here for all kinds of crop, corn as well as green crop, but principally as top-dressing for cutting grass, laid on in March or April, whereby the grass is fully ten days earlier, and the yield much heavier than from land which had not been similarly treated. The comparative qualities of liquid manure, guano, and nitrate of soda, have also been tested by experiments on cutting grass, by which it was found that 3,000 gallons per imperial acre of liquid manure was equal to 6 cwt. of Peruvian guano, costing 12s. 6d. per cwt., and superior to 3½ cwt. of nitrate of soda at 21s. per cwt. Liquid manure has also been applied to young grass in the month of November, in dry weather, and with good effect, the quantity being about 3,000 gallons per imperial acre, and likewise, for several years, to potatoes and turnips in nearly the same proportion. It has been laid on stubble in October, November, and December, and ploughed in, and in spring, when putting in the seed, there was given to that portion of the field which had got liquid manure



Maclure & Macdonald Lith
Glasgow

ten cart-loads of dung per acre, while the other portion got from 20 to 24 loads, yet the crop was always best where the liquid manure had been used. Last year, as an experiment, 3 acres of turnip were entirely manured with the liquid laid on in the usual way of broad-cast; the rest of the field was manured at the rate of 20 cart-loads of good farm-yard dung per acre, and the crop on that portion which had got the liquid manure was superior to that where dung had been used.

In using liquid manure, the writer considers it a great improvement to have the ammonia fixed as recommended by chemists; and, for this purpose, during the last twelve months, he has put 3 lbs. of the strongest sulphuric acid, diluted with four or five times its bulk of water, into the butt of 160 imperial gallons of manure. It has been observed that, if more than 3 lbs. is used, the liquid effervesces so much as to prevent the cask being filled; and it is also proper that the acid and water be well stirred previous to being put into the butt, which had better be about half full when this mixture is added. Formerly the liquid manure, when newly laid on the land, was smelt at the distance of a quarter of a mile, but, mixed with sulphuric acid, the field may be passed through and the smell scarcely perceptible.

The practice of using a good allowance of liquid manure in spring upon dunghills then in preparation for potatoes and turnips, has also been followed, and here the sulphuric acid is highly beneficial in fixing the ammonia. During summer it has also been used in composts of earth, road scrapings, and such like, and always with good effect.

The process for distributing the liquid manure as practised here is very simple:—A sperm-oil butt, which contains about 160 gallons, is placed upon a cart-frame with broad wheels; and secured in the end of the butt is a large cast-iron stop-cock, which discharges the liquid into a box regularly perforated, attached to the rear of the frame or cart, which thus distributes the liquid over a space of four and a-half feet wide, or equal to the width of the wheels of the cart.

When driving out this manure, the writer's practice has been to employ two, three, or four of such carts, according to the distance the field happens to be from the tank. A man is placed at the pump to assist the carter to fill the butt, and another in the field to regulate, by means of the stop-cock, the equal distribution of the liquid, according as the horses travel quick or slow, the carter having thus to attend solely to his horse, and to keeping his *near* wheel *in* the track of the *off* wheel of the cart which had preceded him, and in this way the whole field is regularly gone over.

It is well known that other methods of distribution are em-

ployed, such as having the pump attached to the manure-cart, and having a leathern suction-pipe attached, which is dropt into the tank when the butt is to be filled. A variety of methods also are adopted in the construction of the distributor, such as perforated pipes, boxes with a serrated edge, and sluices to regulate the discharge, with other contrivances that need not be described here. In regard to the portable pump fixed to the cart, it may be noticed that it has some advantages, such as, in the case of using other liquids or solutions, that the cart can be filled out of any vessel, or at any place; but where a practice such as here described has been adopted, where expeditious application is an object, the furnishing of every cart with a pump would be rather expensive, in addition to the cart itself, and it is humbly conceived that the practice here described and followed is, on the whole, both economical and effective.

There remains to be noticed that, in choosing a site for a tank, it should be so placed that the surface of the liquid in the tank, when full, shall be sufficiently below the level of all the sources of supply, as to give a free current from them through the drains or conduits to the tank. It is advisable also that the conduits should be water-tight, for which purpose burnt-clay pipes, of three to four inches bore, properly jointed, are the most eligible; and, to prevent choking of the conduits, their eyes should be defended by a grating, besides having a water-trap or cess-pool immediately under it, to intercept any grosser substances that might enter, and which in time tend to close up the conduits.

It is also worthy of notice that, on some farms, the position of the steading, if on sloping ground, may allow of the tank being so placed as to admit of its contents being drawn off by a pipe and stop-cock, and thus delivered into the manure-cart without the intervention of a pump.

In conclusion, the writer begs leave to remark that, from his experience in the construction of a good tank, he considers that economy, if not directed by judicious views for the attainment of efficiency in the object, will be attended with loss and disappointment; and, from his experience also of the valuable benefits of liquid manure, he would not only strongly recommend the adoption of the tank upon all farms, but that it should occupy a part in the plan of every new steading. Were such a system generally adopted, much of the expense attending the collection of common manure from towns and villages, and of the purchasing of the still more expensive foreign and manufactured manures now so largely applied, might be saved. It may also be important to add, that the first year's collection of the liquid manure, in the case herein described, was considered to compensate in full for all the expenses incurred in the construction of the tank.

NOTES ON THE MANAGEMENT OF SHEEP, founded upon REPORTS of COMPETITORS who gained Premiums at the Wool Competition held at Edinburgh in 1845.

Cheviot Sheep.—Mr Anderson, Sandhope, Selkirk.—The flock consists of about 1000 ewes of ages varying from one to six years, and it was reared exclusively on coarse hill pasture, elevated from 1000 to 2,000 feet above the level of the sea. The stock ewes get no artificial food, except on the occasion of a severe storm, when they are supplied with a little natural hay. To afford such aid, unless urgently required, would tend to lessen the exertion of the sheep to provide for themselves. The tups are bred from selected ewes by the best rams, and put on grass and turnips during winter and spring. The washing takes place about the end of June in a pond, into which the sheep are made to leap from a platform raised about two feet above the surface of the water, and then caused to swim twice or oftener across, as may be necessary for cleansing them. The clipping is performed about eight days after. The animals are laid on a stool, the operator proceeding length-ways in parallel lines an inch in breadth, and making the cuts as low and smooth as possible. The price obtained for the clip of Cheviot wool in 1845 was 28s. 6d. per stone of 24 lbs., and for the black-faced clip, 13s. per stone. Wethers are not kept; but barren ewes, sold from the hill pasture at the end of autumn, weigh about 13 lbs. per quarter. The average weight of a Cheviot fleece is 3 lbs. 7 oz., and of a black-faced, 4 lbs.

The black-faced flock, containing 600 breeding ewes, is similarly managed.

Mr Gentle, Dell, Inverness.—The flock, in which there are 500 shearling ewes, is washed about the 18th June. The sheep are driven three times through an arm of a fresh-water lake, having to leap into the water from a breastwork four feet high, and to swim from thirty to forty yards. The clipping follows about the 22d of the same month. It is done longitudinally, with an even and rather bare cut. The clipper is seated on a smearing-stool, which is covered with a tough sod, to prevent the animals being hurt. The pasturage consists of common mountain grasses, much intermixed with heather, and its altitude varies from 1000 to 2,000 feet above the sea. In winter and spring, however, the sheep, when the inclemency of the weather makes it necessary, are brought to lower ground, at an elevation not exceeding 100 feet. The clips of 1844 and 1845 were sold at 18s. per stone of 24 lbs. Three-year-old ewes have been sold for £25: 10s. per score—a price considered less than their value. Such sheep, getting good turnip feeding till the end of

March, would weigh, on an average, from 18 to 20 lbs. per quarter; but individual sheep have weighed 25 lbs. per quarter. The fleeces of the shearling ewes will be about 4 lbs. weight each on an average; but, taking fleeces of all classes, the average per fleece will be about 5 lbs. The fleeces are understood to consist of laid wool.

Mr Tweedie, Deuchrie, Prestonkirk.—The flock contains from 300 to 400 shearlings. The sheep are washed in June by making them leap three or four times into a pool, and swim fifteen or twenty yards. They are generally clipped within a week after, the shears being used longitudinally. The pasturage is on the Lammermuirs, poor and mostly heath. In winter and spring, turnips and hill pasture are the means of support, each being afforded daily. The clip of hogg and ewe wool in 1845 sold at 29s. 6d. per stone of 24 lbs. For the last five years, a bath mixture, prepared by Brown of Haddington, has been used in autumn, and, while it has kept the stock quite clean, it is easily applied. Three men to dip, and a boy to drive water, can easily bathe 600 or 800 sheep in a day. The apparatus is not very expensive, and it promotes the comfort both of men and sheep. It consists of a tub for dipping, and a large trough in which the sheep, after being dipped, stand to drip, and so constructed that the drippings run back into the tub. Since the adoption of this plan, the wool has always been considered very fine, and, indeed, the best shewn at a local exhibition.

Black-Faced Sheep.—Mr Vere Irving, Newtown House, Moffat.—In the district of Moffat it is not customary to wash black-faced sheep. The shearling and barren ewes, and the rams, were, in 1845, clipped on the 2d July, and the rest of the flock, consisting of ewes rearing lambs, on the 19th of the same month. In 1844, the clipping of the latter class of stock took place some days earlier; but this is not considered advisable, as the wool last season was better risen than in the preceding year. In clipping black-faced sheep, the shears are run from head to tail, but, in the case of Cheviot sheep, they are directed over the shoulder and back. The latter method produces a neater clip; but the former is more expeditious. The farm rises from a base of 910 feet above the level of the sea, to an altitude of 1550 feet above it. The lower portion, which is divided into parks, and is well sheltered, is occupied with dairy-stock, grain, green-crop and hay; and, for the greater part of the year, the sheep are entirely confined to the upper division, or steep ground. The pasture is short and of a bright colour, intermixed with coarse bent, which requires to be burnt in spring. Some years ago, part of the benty ground was ploughed, heavily limed, and sown with grass seed; and thus a great improvement was effected,

the bent having been replaced by a bright green pasturage, which cannot be distinguished from those portions of the ground that are not naturally covered with bent. In winter and spring, the sheep, if their condition seems to demand it, are admitted into such of the lower parks as have been cut for hay, or pastured during the summer by the dairy-stock, which is then fed in the house. The sheep are let down from the higher ground in the morning, but are invariably put out of the parks between one and two o'clock in the afternoon. In the event of a severe snowstorm, they are fed with meadow hay, which is carried out to them. In weaning the ewe lambs intended for stock, they are put into one of the parks for a week, and then allowed to return to their mothers, whom they recognise, but no longer attempt to suck. An advantage of this plan is, that the lambs follow their dams through the winter, and, if there is snow, they are helped by them to scrape, so that they do not so often need to be fed with hay as when they are kept separate all the winter. The last clip sold fetched 12s. per stone of 24 lbs., for fleeces of all denominations.

Cross between Cheviot and Leicester Sheep.—Mr Brown, Halls, Dunbar.—In the flock there are about 600 hoggs. The usual period for washing is about the end of May or beginning of June; and the plan followed is that of placing four or five men in a stream of clear water up to their middle, one above the other, and passing the sheep, one by one, from the lowest to the highest, each man, in turn, plunging the animal in the water. The shearing follows in three or four days, when the natural oiliness of the wool, extracted by the washing, is restored. The operation is performed in an open shed, laid with green sods. One or two women attend for the purpose of freeing the fleeces from particles of clotted wool, and afterwards winding them. The price obtained for the clip last sold was 31s. per stone of 24 lbs. The pasture on which the Cheviot ewes are grazed, from which the half-bred lambs are reared, is situated on the northern boundary of the Lammermuirs. The lambs are weaned about the middle of August, when they are removed to the sown pastures on the farm. In November they are bathed with a mixture of tobacco liquor and spirit of tar, in the proportion of half a Scotch pint of the former to a wine-glassful of the latter for each sheep. They have then a few turnips laid on their pasture, and, when they have fully acquired a taste for them, they are folded on turnips alone during winter and spring, or until grass is ready for them, which, on the high situation to which they are transferred, is, in ordinary seasons, about the middle of April, or beginning of May.

PROCEEDINGS OF THE AGRICULTURAL CHEMISTRY ASSOCIATION.

THE Committee of Management now transmit to the Directors of the Highland and Agricultural Society of Scotland, for publication in the next Number of their Transactions, an Account of some of the Investigations carried on in the Laboratory of the Association since their Report in December 1845.

The account has been drawn up by Professor Johnston, in a series of articles applicable to the several subjects noticed, and forming a continuation of those in the three previous reports.

D. HORNE,
Honorary Secretary.

EDINBURGH, 1*st February* 1846.

XX.—COMPOSITION AND USES OF THE SPENT LEYS OF THE BLEACH-WORKS.

Besides the lime-refuse of the bleachers described in a previous article, (XVII.,) another substance runs largely to waste from the premises of the linen-bleachers. This is the spent leys or alkaline solutions in which the cloth or linen-yarn has been boiled or washed. From most of the large works of this kind these spent leys carry off every year hundreds of tons of alkali into the neighbouring streams.

My attention had been drawn to this fact while visiting the bleach-works in certain parts of Scotland, and I had ventured to offer some suggestions as to the best mode, *under the circumstances*, of economizing this liquid, and turning it to some useful purpose. I lately, however, received a bottle of the refuse leys from the Lambeg bleach-works of Mr Richardson, near Lisburn, in Ireland, with a request that I would examine it chemically, and give an opinion as to its value as a manure. I was thus led to consider the matter more in detail, and the following are the results:—

1°. *Composition of the Liquid.*—On examination the liquid was found to have the following composition—

a, An imperial gallon, on evaporation, left behind 1431.6 grains of solid matter, or *five gallons would leave a pound.*

b, This solid matter consisted of—

Organic or combustible matter,	600 5 grains.
Inorganic matter or ash,	831.1 ..
	1431.6 grains.

The organic matter consisted of colouring matters, resinous substances, and other compounds, which the soda employed had dissolved out of the fibre of the unbleached flax. There is every reason to believe that, under favourable circumstances, these organic substances would readily minister to the growth of plants.

c, The inorganic part, or ash, was found upon analysis to consist of—

	Per Cent	Or a Gallon contained,
Carbonate of Soda, ...	73.17	608.0 grains
Sulphate of Soda, ...	14.43	120.0
Chloride of Sodium, ...	11.22	93.3
Carbonate of Lime, ...	0.26	2.2
Carbonate of Magnesia, ...	0.14	1.2
Oxide of Iron and Alumina, ...	0.23	1.9
Insoluble Siliceous Matter, ...	0.55	4.5
	100.00	831.1 grains

Or it was composed almost entirely of common salt, sulphate of soda, and carbonate of soda, with a small admixture of sand and lime. Of these salts of soda each gallon contained 821 grains, or *every 8½ gallons contained a pound.*

Of course the refuse leys must vary in strength; but, supposing them to have the composition of that which I examined, every 9,000 gallons would carry down about half a ton of soda-salts into the river. A slight acquaintance with the relation which these salts of soda bear to the inorganic constituents of plants will shew how valuable an effect they are fitted to produce when applied, under proper conditions and in due quantity, to our cultivated crops. They are even the more valuable from the large quantity of organic matter with which they are combined, and which they render soluble in water. It is a singular circumstance, though it is one which applies also to many other liquid manures, that it is only the great abundance of it in one place that renders it difficult to apply it all to any useful purpose.

There are two ways in which it may be used. It may either be made into a compost with peat, earth, and the lime refuse of the same works, and applied as a top-dressing to grass-land, or in preparing for the green crop, or it may be employed for the purposes of irrigation. It would be difficult to use up the whole of the waste leys of a large work in the former manner. Could they, however, be turned into a reservoir, and, after being sufficiently diluted, be made to flow over an extent of grass-land, any quantity of them might be turned to profit.

The owners of such works, however, have rarely the opportunity, seldom the extent or kind of land at their command, which admits of such means being adopted by themselves for turning their waste materials to a profitable use, while those in their own neighbourhood who have the means will seldom give themselves the trouble of even making a trial. I know one bleach-work in Scotland from which these saline matters were allowed to run into an adjoining stream in great abundance, until, a short while ago, the proprietors of the river accused them of polluting the water, and have compelled them to make a *lead*, several miles long, to carry them off nearer the sea. How

much better to have considered whether the money thus spent might not have been employed in turning the liquid to some good use than in hastening and securing its escape unmixed to the sea!

There are still some persons who are opposed to the general diffusion of elementary scientific knowledge among the agricultural classes. But knowledge is the only sure extinguisher of prejudices—the only irresistible remover of hindrances to the progress of the arts of life. However much, therefore, we may lament and complain of instances of large and unheeded waste, such as that above described, we cannot expect to see things generally altered until such knowledge is more widely diffused. When the agricultural community have been generally taught to see and understand the purposes served in reference to the growth of plants, by substances which, in any locality, may happen to run to waste, and thus to understand the uses to which they may naturally be applied, we may expect that they will carefully collect and everywhere work them up of their own accord. But, while they remain in ignorance of the principles on which the uses of such substances are based, we shall always meet with disappointment in endeavouring to persuade them to do what our better knowledge teaches us would be manifestly to their advantage. This is one of the reasons why the Agricultural Chemistry Association consider the diffusion of such knowledge, in every available way, as so necessary to the success of their exertions for the improvement of Scottish agriculture, through the application especially of chemical science.

XXI.—COMPOSITION OF THE FIRST AND SECOND REFUSE OF THE SCOTTISH DISTILLERIES.

Another illustration of the observations above made may be drawn from the waste of the valuable refuse of the Scottish distilleries, which takes place to a great extent in some parts of the country.

We have seen, in a former article, (XIII.,) that the water in which barley is steeped, before it is malted, extracts various saline and other substances from it, which impart to this steep-water a considerable fertilizing value. But, after it is malted a much larger portion is extracted by the worts, and remains in them even after these worts are fermented and fined by the brewer or the distiller. These substances remain, to a considerable extent, in the beer, as we have also seen in a preceding article, (XIV.,) but, when the fermented worts are distilled by the whisky manufacturer, they all remain behind in the still after the spirit has been drawn off.

The refuse of the stills is muddy, and more or less thick, and

contains sugar, gum, altered starch, protein compounds, and saline matter—all in quantities which vary with many circumstances. Many of the distillers, who keep cattle to eat up their *draff*—the exhausted husks of the barley—give this still-refuse as a drink to their stock, and in this way turn it to a profitable account. Others give it to their milk-cows, or sell it to the dairymen, when they are near a large town, or to the pig-feeders, who find it a profitable article to purchase. By the latter class, in the suburbs of Edinburgh, it is often kept for months in large tanks till it sours, and, as they say, *sweetens again*. In country districts, as in parts of Mid-Lothian, the farmers buy it, and carry it for several miles in large casks, for the purpose of mixing with and enriching their ordinary manure.

During my visit to Islay, last summer, I observed a milky liquor running into the sea, in large quantities, near Port-Helen, and, on inquiry, I found it to proceed from the distillery of Mr Ramsay, and to consist of the still-refuse above described. Upon inquiry, I learned, from Mr Ramsay, that he could not use it all up himself, that none of his neighbours about Port-Helen thought it worth the trouble of carrying away, and that about 10,000 gallons a-year were let off into the sea from his distillery alone. I suppose that, from the other distilleries in Islay, of which there are now, I believe, six or eight, a similar waste takes place.

At the request of Mr Ramsay, I brought with me to Edinburgh two bottles of this refuse, for the purpose of submitting it to a chemical examination. The one contained the more fluid portion of the liquid, the other the thicker matter, which subsides in the tank into which the liquid runs when it is first drawn from the stills. The results of the examination of these two liquids were as follow:—

1°. *The thinner liquid.*—An imperial gallon of this liquid left on evaporation 4,235 grains; or *every five gallons contained upwards of three pounds of dry solid matter.*

This solid residue consisted of—

Organic Matter,	3,871 grains.
Inorganic Matter,	364 ...
	4,235

The *organic matter*, as I have already said, consists of gum, sugar, protein compounds, &c., all more or less changed, but all fitted still to minister to the nourishment both of animals and plants. *Of this mixed matter every gallon contained upwards of half-a-pound.*

The *inorganic part* was found, upon analysis, to contain—

	Per Cent.	Or an Imp Gallon contained,
Potash and Soda, with a little Sulphuric and Muriatic Acids,	46.24	168 grains.
Phosphoric Acid, (combined in the liquid with some of the above Potash and Soda,)	21.67	79 ...
Phosphates of Magnesia and Lime,	28 88	104 ...
Siliceous Matter,	2.56	10 ...
Loss,	0.65	3 ...
	100	364

The reader will be struck, on inspecting the above numbers, with the large proportion of phosphates contained in the saline residue of this liquid. In fact, with the exception of a little siliceous matter, it consists almost entirely of the mixed phosphates of potash, soda, lime, and magnesia. The known value of these phosphates, both to the growing plant and to the growing animal, fully establishes the fact that there is a serious loss to the country in the large waste of this liquid which is constantly taking place, and, therefore, that every *economically* available means should be adopted for preventing it in future.

2°. *The thicker liquid*, which is deposited at the bottom of the tank, is of sufficient consistence to be given alone as food for pigs, while the thinner liquid is more fitted for a drink for cattle.

An imperial gallon of this liquid left 10,884 grains of dry solid matter, or *two gallons contained upwards of three pounds of dry food.*

To many this proportion may probably present itself in a more striking light, when I state that *this thick liquid contains about one-fourth more dry food than an equal weight of turnips.*

This solid residue consisted of—

Organic Matter, ...	10,290 grains.
Inorganic Matter, ...	594 ...
	10,884

Thus the organic matter—the gum, sugar, protein compounds, &c.—form by far the largest proportion of the solid matter contained in the liquid.

The inorganic part, or ash, upon analysis, was found to contain—

	Per Cent.	Or an Imp. Gallon contained,
Potash and Soda, with a little Muriatic and Sulphuric Acids, ...	38.36	226 grains.
Phosphoric Acid, (combined in the liquid with Potash and Soda,)	24.35	145 ...
Phosphates of Magnesia and Lime, ...	15.90	94 ...
Siliceous Matter, ...	20 95	124 ...
Loss, ...	0.44	5 ...
	100	594

Here also, as in the thinner liquid, the phosphates, and especially the alkaline phosphates, abound, forming nearly the whole of the ash indeed, with the exception of the siliceous matter, which, in this sedimentary part, is present in considerable quantity.

This siliceous matter is, of course, of no value in feeding, though it will not be without its influence in promoting the growth of a corn or grass crop, when the refuse is used as a manure. The presence of this large quantity of silica, however, is physiologically interesting. It must have been extracted from the husk of the malt in the mash-tub, during the preparation of the wort, and the point of interest is, that so much of the silica of the husk should exist in this readily soluble state, and should be so easily taken up when the grain is immersed. This fact is, no

doubt, connected with the purposes which this silica is destined to serve during the germination of the seed after it has been sown in the soil—a point to which I shall have occasion to refer more particularly in a subsequent article.*

The above analyses sufficiently demonstrate the value of the two forms of this first distillery refuse—the thinner and the thicker liquids—both as a manure for corn and grass crops and as food, especially for young and growing animals. I think it likely that the thicker liquid might be advantageously put into the drills as a manure for the potato, and perhaps also for the turnip. Will any of the members of the Association give it a trial as a manure? If it cannot conveniently be applied in the liquid state, it can easily be dried up by earth, chaff, saw-dust, bran, or any similar material.

As I have above alluded to the comparative proportions of dry food contained in the turnip and in the thicker of these two liquids, it may be interesting to present a comparative view of the relative proportions of water and of organic and inorganic matters in each of the liquids, and in turnips of average constitution. A hundred pounds of each contain these three kinds of matter nearly in the following proportions:—

		Distillery Refuse,	
	Turnips.	Thick.	Thin.
Water, ...	89	85¼	93½
Organic Matter, .	10¼	14	6
Inorganic Matter, .	¾	¾	½
	100	100	100

This table shews that, both as respects the organic and the inorganic constituents, *the thin liquid is equal in nutritive or manuring value to half its weight of turnips, and the thicker liquid to fully its own weight of the same root.*

3°. *The* second refuse *of the distilleries.* The produce of the first distillation—the raw spirit—is put into the still a second time and distilled off, leaving a second residue behind. A portion of this residue was forwarded by a member of the Association in Morayshire for examination in the Laboratory, but it proved to be of no value. It was clear and colourless, and freer from foreign matter than most of our common spring waters. This was to have been expected; for except the volatile oils which accompany the spirit, and, perhaps, a little vinegar, little else but watery vapours can escape through the worm during the first distillation.

XXII.—ANALYSIS OF THE URINE OF THE SHEEP.

The urine of animals is now pretty generally understood to be valuable as a manure for nearly every kind of crop; but the

* See subsequent Article *On the Composition of the Ash of Barley Sprouts.*

urine of all animals is not equally applicable to this purpose, as they do not all contain the whole of those substances which our cultivated crops require. The urine of omnivorous animals, such as that of man and of the pig, contains phosphoric acid in combination with the alkalis, and with lime and magnesia; but that of herbaceous animals, in general, is destitute of this important food of plants. The ox and the horse discharge the whole of the phosphates contained in their food along with their solid excretions, so that their urine contains none; and the *hare* is the only herbivorous animal yet known in the urine of which these phosphates have hitherto been found in considerable quantity.

It is probably because of the difficulty of obtaining the urine of the sheep that it has not hitherto been examined. I had recourse, therefore, to the butcher, who furnished me with a number of sheep's bladders, containing urine in the state in which they were cut out of the body of the newly slaughtered animal. The contents of these bladders I put into the hands of my assistant, Mr Fromberg, with instructions to direct his principal attention to its inorganic constituents, and especially to examine it for phosphates. Mr Fromberg accordingly submitted it to examination, with the following results:—

1°. When evaporated to dryness, 100 parts by weight left 7 of dry matter—*or* 10 *gallons of the urine held in solution* 7 *lbs. of dry fertilizing substances.*

2°. This dry matter, when burned, gave off ammonia, and left a large proportion of ash. It consisted in 100 parts of—

	Per cent.
Organic Matter containing Nitrogen,	71.86
Inorganic or Saline Matter,	28.14
	100

3°. The saline matter or ash was composed as follows:—

Composition of the Inorganic part of Sheep's Urine.

Sulphate of Potash,	2.98
Sulphate of Soda,	7.72
Chloride of Potassium,	12.00
Chloride of Sodium,	32.01
Carbonate of Soda,	42.25
Carbonate of Lime,	0.82
Carbonate of Magnesia,	0.46
Phosphates of Lime, Magnesia, and Iron,	0.7J
Silica,	1.06
	100.00

The urine of the sheep, therefore, contains only a very small quantity of phosphoric acid in combination with lime and magnesia. It agrees very closely in this respect, therefore, with that of the ox and the horse, in which no trace of phosphates has yet been detected. It abounds also, as the urine of these animals does, in salts of potash and soda. It is especially rich in common salt and in soda, which, in the ash, is in the state of carbon-

ate, but which in the urine is, no doubt, combined with some organic acid. *If it be natural to the urine of healthy sheep to contain so much soda, we may find in this one reason why they relish salt so highly, and thrive so much better when it is abundantly supplied to them.*

4°. The organic part contained, as was to be expected, a considerable proportion of urea, a substance which, during the fermentation of the urine, is changed into carbonate of ammonia. The following table represents the entire composition of the urine, both of the inorganic and of the organic parts, so far as time permitted the latter to be submitted to examination:—

Composition of Sheep's Urine in 1000 *parts.*

Water,		928.97
Urea,		12.62
Organic Matter soluble in Alcohol, (sp. gr. 0.83,)		33.30
Organic Matter soluble in Water, insoluble in Alcohol,		3.40
Organic Matter soluble in weak Potash, insoluble in Water and Alcohol,		0 10
Organic Matter insoluble in any of these liquids,		0.15
Inorganic Matter, consisting of—		20.09
Sulphate of Potash,	0.51	
Sulphate of Soda,	1.32	
Chloride of Potassium,	2 05	
Chloride of Sodium,	5.47	
Chloride of Ammonium,	3 06	
Carbonate of Soda,	7 22	
Carbonate of Lime,	0.14	
Carbonate of Magnesia,	0.08	
Phosphate of Lime and Magnesia, with trace of Phosphate of Iron,	0.12	
Silica, with trace of Oxide of Iron,	0.18	
		998.63

The urine of the sheep, therefore, is to be classed along with that of the ox and the horse. It contains a trace of phosphates; but, like the above animals, the sheep excretes most of the phosphates of its food in its solid droppings. The urine of this animal, therefore, though rich in soluble saline matter, and in substances yielding ammonia, would not be sufficient of itself to maintain the fertility of any land not naturally rich in the earthy phosphates. It is the conjoined action of the urine and of the solid droppings of the sheep trodden in together, which renders this animal so valuable a servant in fertilizing the fields of the practical farmer in so many parts of our island.

XXIII.—COMPOSITION AND RELATIVE VALUES OF TWO KINDS OF SALT EMPLOYED IN THE MAKING OF CHEESE.

The *stoning* of cheese is a process of much importance in dairy districts, and upon the nicety and skill with which it is performed the quality of the cheese in a considerable degree depends.

The object of the stoning or pressing is chiefly, of course, to press out water, and perhaps air, from the interior of the cheese, and thus to make it more compact, drier, and denser. This, however, must be done gradually and gently, and, therefore, is a work of considerable time. In hot summer weather it often becomes a matter of considerable difficulty, in consequence of the drying and hardening of the skin of the cheese, and the consequent closing up of the pores by which the water ought to escape. Hence the cheese-press is placed, if possible, in a situation where a moderate and pretty uniform temperature can be kept up, and hence also numerous precautions are taken by skilful dairymaids, by frequent wetting and washing the cheese-cloth, and otherwise, to keep the skin soft and kindly, and its pores from being closed.

Among the circumstances which not unfrequently affect the ease and perfection of this stoning process, it has been observed that the kind of salt employed, either for mixing with the curd or for rubbing on the outside of the cheese, has a perceptible influence. My attention was first called to this circumstance in the summer of 1844, by Mr Finlay of Toward Castle, who sent me two samples of salt to be analysed, accompanied by the following letter:—

CASTLE TOWARD, GREENOCK,
2d July 1844.

SIR,—I take the liberty of sending to your address, with this note, two samples of salt, one marked—

No. 1—Saltcoats, and the other
No. 2—Common,

which I should like you to analyse, for the purpose of ascertaining why sweet milk cheeses, into which the former is put, stone better than those made with the latter.

This summer I have been making sweet milk cheeses with the milk of twelve cows; and the dairymaid has found, as usual, difficulty in extracting the whey. This, I believe, is a general complaint this season; and it is supposed by some to be owing to the state of the weather or pasture. Although we made the same kind of cheeses last year, with the same dairymaid, and the cows on the same pasture, we have found very much greater difficulty in extracting the whey this year than last.

We are obliged to keep the cheeses eight, nine, and ten days under the press, and last year three or four was sufficient.

This is a great inconvenience, and some additional expense; but would be of comparatively little importance if the cheeses, after all, were thoroughly dried, which, however, has not been the case; for it has frequently happened that cheeses which appeared hard and dry when taken out of the press, in a few days began to sweat; numerous drops of whey oozing out, causing cracks, and greatly injuring the cheese.

I happened to mention this circumstance to a tenant who has a large dairy, and he recommended me to try Saltcoats salt instead of common salt, which I did, and I now find that none of the cheeses made with this salt are subject to suffer from whey oozing out after being taken from the press, although they still require to be longer in the press than we should like—say about seven or eight days.

The object I have in view in sending these salts is to ascertain, if possible, the cause of the difficulty we have this season experienced with our cheeses, and to discover a remedy.

It is a matter of much importance to dairy-farmers, and I shall be glad to hear from you, at your convenience, on the subject.—I am, &c.

ALEX. S. FINLAY.

In a subsequent letter, Mr Finlay informed me that the sample which he had sent under the name of common salt, was Cheshire salt, obtained from Liverpool. The two samples, when analysed, were found to have the following composition respectively :—

	Saltcoats.	Liverpool.
Chloride of Sodium, (Common Salt,) .	92.38	97.36
Chloride of Calcium, ...	1.26	0.93
Chloride of Magnesium, ...	0.64	—
Sulphate of Soda, (Anhydrous,) . . .	2 42	1.51
Moisture, ...	3.01	0.08
	99.71	99.88

These results given by the two salts, on analysis, suggested to me an explanation of the fact described by Mr Finlay, which I ventured to offer him in the following report :—

8, Bank Street, 2*d August* 1844.

Sir,—I have the pleasure of enclosing a copy of the results of an analysis of the two samples of salt received from you some time ago for examination. You will observe that the Liverpool salt is the purest, the Saltcoats salt containing more lime, magnesia, and sulphuric acid than the other.

In regard to the curious and interesting question you have asked me to solve, I confess I can only give you a probable, but what appears to me not an unlikely, solution.

It is recognised, I believe, by cheese-makers generally, that weather which is neither too dry nor too moist is most favourable to the quick and perfect stoning of the cheese. The moist weather acts by hindering the drying of the cloth and surface of the cheese while under the pressure—the dry weather dries both too rapidly, and makes the crust of the cheese comparatively hard, and very close and impervious to the water within.

You know that, when milk is heated upon the fire, a very close and compact skin or brat forms upon its surface, impervious even to the steam which rises from the milk, and which, therefore, lifts up the skin and makes the milk boil over. In warm weather a similar skin forms upon the cheese, and, though you apply the usual pressure, the water from within will escape with great slowness. *It will take too long to dry*, and, if you take it out of the press and expose it to the free access of dry air, the cheese will dry, but it will crack, as you describe ; or, if it is kept in a cool place, the crust will soften, and the moisture will ooze out from within, or the cheese *will sweat.*

All this will happen provided you use *pure salt*, and employ no means for keeping the crust soft and porous. The common salt you used was such comparatively pure salt, and, therefore, the appearances I have described presented themselves in the dairy.

Now the *Saltcoats* salt being less pure—containing, in particular, chloride of calcium and chloride of magnesium, both of which are deliquescent, or attract moisture from the air in the warmest weather—would never permit the outer crust of the cheese to become so very compact and impervious as the Liverpool salt did. The impurities it contained would always keep the crust in a certain state of moisture and openness, so that the whey from within would find a more or less ready passage through it to the cloth, by which it would be absorbed.

This appears to account for the more rapid and perfect stoning of the cheese cured with the impure salt. Had it contained still more impurity—been more deliquescent in the air than it is—its superiority over the common salt would in this dry season have been still more manifest ; or, had you been able to rub over the surface of the cheese now and then with the mother liquid of the salt pans, which contains much chloride of magnesium, this good effect might have been produced, (*probably*,) though the curing had been effected by the *common* salt. I am not sure that it would be safe to mix this mother liquor of the salt-works at once with the curd, as it might affect the keeping or flavour of the cheese.

The above is, I think, a very probable explanation of the fact you mention. It is not at all unlikely that the quality of the pasture, the drought of the season, and

other circumstances, may so affect the natural quality of the curd, or the richness of the cheese in butter or in saline matter, as to produce something like the effect you describe upon the whole of your cheese. That it all stones less rapidly than usual, whatever kind of salt is used, is in favour of this opinion; but it is safer, I think, not to suppose the agency of any such influences, if the causes I have mentioned be really such as could produce it.

I have been very much interested, and at first rather puzzled with your inquiry; I hope, therefore, it will not be long before you meet with some other similar fact, and that you will do me the favour to bring it under my notice.

ALEX. FINLAY, Esq., Toward Castle.

In a later communication Mr Finlay offered to undertake any further experiments, with deliquescent or other salts, which I might think of suggesting to him. The subject, however, was too new to myself, and I knew too little of the niceties of cheese-making to be willing to run the risk of suggesting trials which might lead to failure and the injury of many cheeses, arising either from my own ignorance of the subject or from the mismanagement of the dairy-maid.

I have, since that time, had opportunities of attending to all the details of the stoning process—especially in the well-managed dairy of my friend Mr Alexander of Ballochmyle, at his farm of Wellwood, in Ayrshire—and I have ascertained that the quickness of stoning depends very much upon the management. It is usually effected in this part of Ayrshire in about four days. The weather affects it, but the constant attention of the skilful dairy-maid defeats the action of the weather, and preserves a pretty uniform progress in the several stages of the cheese-making process.

Still the fact of Mr Finlay remains untouched. Greater care and skill may overcome the tendencies of the season, but why is this greater care necessary? Why does the quality of the salt affect the rapidity of the stoning process, the care, and skill, and weather being the same? I am still inclined to think that there is a foundation of truth in the explanation I have given in my letter to Mr Finlay. The summer is coming, however, and I beg to call the attention of members of the Association to the subject—to ask them to make inquiries, observations, and experiments regarding it, and to favour me with any new information they may happen to possess, or may be fortunate enough to acquire.

I have said above, that, in the summer season, when the herbage cropped by the cow differs in composition, as we know, from that of the other seasons of the year, the cheese itself may have some peculiarity in composition. It may hold more or less butter or saline matter, or the curd may be in some peculiar state which will affect its conversion into cheese. If this be the case, the question proposed by Mr Finlay is altogether a chemical one, and can only be solved by prolonged and rigorous chemical

inquiry. I am at present, therefore, directing my attention to the cheese itself, and am causing experiments to be made with the view of ascertaining the nature of the differences in chemical composition, which, no doubt, attend the numerous well understood differences in its economical quality. A knowledge of these differences will lead us so far towards a more thorough solution of the problem which forms the subject of the present article.

XXIV.—ON THE USE OF BONES AND LIME IN THE IMPROVEMENT OF HILL PASTURES.

There are two considerations which naturally point to the use of bones and of lime in the improvement of high pasture lands, and to the peculiar circumstances by which their economical use is indicated. Thus:—

1°. The rains which fall on high districts of country naturally dissolve many substances out of the surface-soil over which they flow or through which they penetrate. Among these substances lime is one which is always present in our mountain and hill country streams when they reach the low lands that border them. In course of time, therefore, the soil of every sloping country ought to become poor in lime, from the action of this cause alone; and as lime is necessary in our climate to the luxuriant growth of all our cultivated crops, the addition of lime to such land may be expected to increase its productiveness.

But if there be in the hill country or in its rocks any natural source of lime, the springs which rise through the soil, and even the waters that descend from the heights, may bring with them enough to keep the slopes of moderate elevation in a state of average fertility, in so far as the presence and action of lime are concerned. The necessity of lime, therefore, and the advantage of applying it, will not be so great on hill pastures which rest on limestone or on trap (whinstone) which contains much lime—or over which higher mountains rise in which these rocks abound, and from which the rains can bring down lime to replace what the lower slopes are constantly losing by the agency of natural causes.

2°. The feeding of growing stock—whether sheep or cattle—on hill pastures, naturally removes from the soil the earthy matters which enter into the composition of their bones and of the other parts of their bodies. Confining our attention to the bones alone, if we consider that an animal of 20 to 25 stones weight (Dutch) contains about 50 lbs. of bone, the important constituents of which it derives from the soil, it will easily be understood how the rearing of thousands of growing stock on a hill-side, and for successive generations, should impoverish the soil of the materials of bones, and how, therefore, the application of bones as a manure should increase its productiveness in those

grasses from which the animal derives the materials of which its bones are built up.

It is by the application of these two theoretical deductions to the treatment of their high pastures, that skilful practical men in various parts of the country have been led to the use of lime and of bones more or less mixed with certain saline substances not naturally present in the bone alone. The subject is one of much interest in many parts of Scotland at the present time, and it was selected as one of the topics for discussion at the late Agricultural Breakfasts of the Association at Dumfries. I take this opportunity, therefore, of drawing the attention of the members to the results of some experiments on the use of bones and lime as improvers of high pasture land, which have been communicated to me by Mr Fleming of Barochan, in Renfrewshire, and by Mr Stewart of Hillside, in Dumfriesshire. They will, I hope, satisfy many other practical men of the *economy* of using bones as a manure even on hill pastures, and will be the means of bringing out farther information regarding the results of experiments, which cannot fail to be interesting to the holders of the extensive grazing lands in the south and west of Scotland, and to the sheep-farmers in the north.

4°. In regard to bones, Mr Fleming writes—" I have had very satisfactory results this year (1845) from top-dressing meadows and grass, on the new moor property I lately purchased, with dissolved bones and guano and salt. The produce has been doubled at the trifling expense of 16s. per acre, so that I shall cultivate little up there, but shall turn my attention to the meadows, and to the improving of my grass on the high lands, with the view of wintering my stock on the low lands and in sheds." The land here referred to is, I believe, 500 or 600 feet above the level of the sea, and, when it came into Mr Fleming's hands, was in a very wet, worn-out, and neglected condition.

Of bones as an improver of such grass-land in Annandale in comparison with lime, Mr Stewart has given me the following result:—

" To two portions of cold clay-land, *drained*, ploughed perhaps twenty years ago, and since lying in grass, I applied respectively—

" *a*, *Bones* at the rate of 32 imperial bushels per Scotch acre, costing 2s. 8d. per bushel, including carriage—in all, £4 : 5 : 8 per Scotch acre.

" *b*, *Lime* at the rate of 180 imperial bushels of shells per Scotch acre, at 6d. a bushel, including carriage—in all, £4 : 10s. per Scotch acre.

" The effect is mostly in favour of the bones, both in the quantity and in the quality of the pasture and hay. I have had such trials made on the same fields five years, three years, and two years ago, and the superior effect of the bones will continue, I believe, for many years."

"On dry land," he adds, "that is, as a top-dressing for old pasture grass, the effect *is the reverse.* Lime is here the best according to my trials. I have not yet examined the relative effect of the two substances on rough wet pastures never ploughed."

The above remark of Mr Stewart, that on dry land lime is better than bones, can only apply, of course, to the spots on which his experiments were made. The relative effects of these two substances depend, as I have already explained, upon something more than the mere dryness of the soil—on the presence or absence namely of the constituents of bones, and on the kind of treatment to which the land has previously been subjected.

5°. Respecting the form in which lime is best applied to grass-land Mr Stewart makes the following observation:—

"On old grass-land *much fogged*, lime when laid on in the flour, newly slaked, has much less effect and is less permanent than when laid on some months after it has been slaked, and is spread in the *drachel** or wet state, almost like mortar. On comparing parts of the same field, in the same circumstances, after ten years, the difference is most decided. I find all the observing farmers who use lime are now discovering this, after thousands of pounds have been erroneously spent by myself and others."

This fact, when first communicated to me by Mr Stewart, was new to myself. It has since been repeated to me by other Dumfriesshire farmers, and I am told that a similar observation has been made in the dales of Yorkshire. Upon inquiry, I am led to understand that the immediate effect of the application of the lime in the two states is not very different, but that those good effects are observed for a longer period when it has been applied in the wet state.

If this be the state of the fact, the explanation seems to be, that by the long exposure to the air, the wet lime has been in a great measure reconverted into carbonate, and its particles perhaps a little cemented together. Both of these circumstances tend to render the lime less soluble in water than when newly slaked, and therefore less liable to be washed out by the rains that fall on these sloping pastures, or by the waters which flow down upon them from above. It is easy to see how, after a lapse of ten years, this unequal effect of the rains should become apparent upon the quality of the grass, in so far as this quality is dependant upon the proportion of lime contained in the soil.

XXV.—ON THE STEEPING OF SEEDS IN SULPHURIC ACID.

In the summer of 1844 I received a communication from Mr George Dalziell, Holm of Drumlanrig, informing me that he had

* I fancy this is from the same root as the English *draggled.* Other farmers talk of the wet or *dabby* state of the lime.

tried the steeping of seed-barley in diluted sulphuric acid before sowing it, with, as it then appeared, a very marked effect on the luxuriance of the crop. In August 1845, in answer to my inquiries, he farther informed me, "that the difference was very marked in all the stages of growth, and that, in the end, *the quantity per Scotch acre was eight bushels more on the land sown with the steeped than in that sown with the unsteeped grain.*"

This fact is a very curious one, and I publish it now in the hope that, during the present season, the experiment may be repeated on other soils, in other districts, by different parties, and on different varieties of barley, and the results communicated to the public either through the Association or otherwise.

But this experiment of Mr Dalziell, though no doubt original on his part, is not the only one which has been made in regard to the effect of acid steeps in promoting the growth of corn.

In the account of the eighth annual meeting of the German agriculturists at Munich, in 1844,* I find an account of experiments made in Silesia by Tinzmann, to the following effect:—

Barley steeped six hours in sulphuric or muriatic acids, diluted with forty waters—about 5 lb. of acid per acre—*gave one-fourth more grain and straw.* Steeping in pure water gave more straw, but a very slight increase of grain. The same quantity of acid diluted with water, and sprinkled over the ground before sowing, gave very little increase.

When diluted with forty waters, the sulphuric acid browned the outside of the grain. but did not prevent its growing well; it ought, however, for safety, to be diluted with fifty or sixty times its weight of water.

Tinzmann also tried the sulphuric and muriatic acids upon wheat, oats, and vetches, and upon turnip† and grass seeds, and states that, in all cases, he found the steeped seeds, especially when sulphuric acid was used, do better than the unsteeped. He adds, however, that the acid must be used with precaution, that wonders are not be expected from it on poor exhausted soils, and that it is on soils which have been long in good cultivation that its effects are most observable.

XXVI.—SUGGESTIONS FOR EXPERIMENTS ON THE STEEPING OF SEED BARLEY.

The experiment suggested by the preceding article may be made more interesting by making along with it a series of other

* Bericht uber die achte Versämmlung Teutscher Land und Forst wirthe zu Munchen von 30th Sept. bis 7 Oct. 1844, p. 244.

† An annoymous correspondent, who some time ago requested me to turn my attention to the steeping of turnip seed, may take a hint from Tinzmann's experiments.

experiments upon steeping, which are connected with points of practical and physiological interest. Thus :—

1°. In a previous article, (XIII.,) I have stated that when barley is steeped for the purpose of malting, the water, which is several times renewed, extracts from it a considerable proportion both of organic and of inorganic matter. The inorganic part of the extract is rich in alkaline matter and in phosphates, all of which must be lost to the seed, and yet it sprouts well in the hands of the maltster notwithstanding. Is the saline matter which the grain thus loses necessary to its healthy or perfect condition? Is it necessary to its growth in ordinary soils? Is it a provision of nature by which a store of these substances is laid up in the seed above what is required for its own perfect developement, with the view of meeting the emergency of its being placed in a soil in which these substances are unusually deficient? Or are we to consider as only accidentally present the saline and other compounds which are thus easily extracted from it by simple steeping in water?

These are interesting questions, especially to the chemical physiologist, and it would be very interesting to solve them. If the seeds sprout and the plants grow as well, and yield as good a crop on all soils, after these salts are extracted by water, as when the unsteeped seed is sown, or seed steeped only in so much water as it can absorb, then we may infer that what the water extracts is not necessary, and that the seed would perform all its natural functions as well without their presence. In that case we should be justified in concluding that they formed no part of the necessary and natural constitution of a healthy seed.

2°. But if, on the other hand, the seed thus exhausted by water grows less vigorously and yields a small return, then we should be justified in concluding, not only that these saline matters which water extracts are really necessary to the perfection of the seed, but of inquiring whether the seed might not with advantage be provided with a larger portion—be beneficially steeped, that is, in a solution which would still further charge it with these saline substances, before it was committed to the soil.

The answer to this inquiry would be obtained by steeping the grain in a solution containing the same or similar substances to those naturally present in the perfect seed. Such a steep would be obtained by the use of a mixture consisting of phosphate of soda, sulphate of magnesia, nitrate of potash, common salt, and sulphate of ammonia. One pound of each of these substances dissolved in 10 gallons of water, will be sufficient to steep 300

lbs. of seed, which may remain in the solution from 30 to 50 hours, and should be afterwards dried with gypsum or quick lime.

The quantity of saline matter above prescribed is sufficient to impregnate the grain with an additional portion equal to that which it naturally contains.

3°. It is possible that after the grain has been extracted by water, it may again be impregnated beneficially with an artificial saline solution, such as that above described, or by a solution of one of the substances only of which the mixture is composed—of nitrate or phosphate of soda, for example, or of sulphate of soda.

Most of these experiments bear more or less directly upon practical operations, but they are especially interesting to the physiologist. I would, therefore, venture to suggest to such of the members of the Association as can appreciate the beauty and importance of such inquiries, that advantage might be derived, and considerable knowledge obtained, by the careful performance of such a series of experiments as the following upon the steeping of barley:—

Seed steeped and washed in repeated waters.	Steeped in as much water only as it can absorb.	Steeped in diluted sulphuric acid. (Art. xxv.)
Steeped in diluted muriatic acid. (Art. xxv.)	Steeped in mixed saline solutions as above.	Steeped first in water and then again in the mixed saline solution.
Seed steeped in nitrate or phosphate of soda.	Steeped first in water, and then in nitrate or phosphate of soda.	Dry unsteeped grain.

I am certain that some of these experiments, at least, will be attended to by the cultivators of scientific agriculture during the ensuing season.

XXVII.—ON THE PROPORTION OF WATER CONTAINED IN SOUND AND DISEASED POTATOES.

It has been very generally stated within the last few months, by writers and speakers upon the potato disease, that the affected tubers of this season contain an unusual proportion of water, while the sound tubers contain only the average quantity.

Few persons in this country, I believe, have made a sufficient number of determinations of the proportion of water in sound and unsound potatoes of different varieties in the present year, to be entitled to give a positive opinion on the subject. I have, therefore, caused numerous experiments on the subject to be made in my laboratory, and the *general* result is by no means in favour of the opinion above stated. If this result should be confirmed by farther examination, then any supposed connexion of the quantity

of water in the potato with the cause of the disease to which it is this year subject, must be given up.

1°. It is of consequence in forming a sound opinion upon this point that we should know with some degree of accuracy the average proportion of water found in potatoes of different varieties in former years and by different experimenters. The mean results of 90 experiments made upon healthy potatoes in France and Germany in former years have been as follows :—

			Water per Cent.
Körte,	mean of 55	varieties,	75.1
Einhoff,	... 5	...	76.3
Lampadius,	... 4	..	74.5
Pfaff,	... 19	analyses,	76.6
Payen,	... 7	varieties grown on the same soil,	74.3
General mean,			75.3

We cannot, therefore, I think, be far from the truth, in assuming that sound potatoes on an average contain 75 per cent., or three-fourths of their weight of water.

2°. But to guard against error, it is also necessary to know the limits within which the per-centage of water varies in the healthy tuber. Without knowing this, indeed, we may be led by a limited number of experiments to conclude that the potatoes we are examining are unusually rich or unusually poor in water, while in reality the proportion of this constituent is quite within the limits which are frequently met with. The largest and smallest quantities found by the above experimenters were as follows :—

	Maximum.	Minimum.	Mean of the Whole
Körte,	76.0	68.0	75.1
Einhoff,	81.3	73.0	76.3
Lampadius,	77.5	70.3	74.5
Payen,	79.4	68.7	74.3

3°. The results hitherto obtained in my own laboratory are embodied in the following table :—

Variety of Potato.	Where from	By whom Sent	Sound or Diseased	Water per Cent		Remarks.
Hen's nest	Houghton Castle	Mr Smith	diseased	75.99		One week in the Laboratory.
do	do	do	do	75.58	76.63	
do	do	do	do	78.34		
do	do	do	sound part of same	75.14		
do	do	do	do	76.87	76.12	
do	do	do	do	76.36		
Seedling potato	do	do	diseased	81.09		
do	do	do	do	80.85	10.97	Do. do.
do	do	do	sound part of same	79.23		

Variety of Potato	Where from	By whom Sent.	Sound or Diseased.	Water per Cent	Remarks
Purple kidney	Newton	Mr Milne	sound	73.88	About 4 days in the house.
White do	Berwick-on-Tweed	do	do	75.23	
Tartar potato	Fifeshire	Mr Duke	diseased	77.22	
Buff do	do	do	do	79.12	
Red potato	Ballochmyle	Mr Alexander	do	80.78	For about 2 weeks in the Laboratory
do	do	do	do	78.89	
do	do	do	sound part of same	78.13	Same kind of potato after lying several weeks in the Laboratory
do	do	do	diseased	71.28	
do	Lanark	do	sound	77.26	About 2 weeks in the Laboratory
do	do	do	do	76.07	
White potato	Drummore	Mr Aitchison	do	80.00	Same kinds of potato, for more than 4 weeks in the Laboratory. Diseased part dry-looking surface almost like cork
do	do	do	diseased part of another	71.77	
do	do	do	sound part of same	77.37	
Pink-eyed kidney	Hexham	Mr Harbottle	sound part of a diseased potato	71.32 72.69 73.08 — 72.36	Only 2 or 3 days in the Laboratory
do	do	do	diseased part of the same potato	83.50 82.09 81.09 — 82.23	

If from the above table we extract the limits of variation in the per-centage of water and the general means, we obtain the following numbers:—

	Maximum	Minimum	Mean
In the *sound* potatoes, or parts, . . .	80.00	72.36	78.56
In the *diseased*, ...	82.23	71.28	76.87

If we were to judge from these mean numbers, we should say that the sound potatoes, or parts of potatoes, contained more water than the unsound. It is true that the maximum is greater in the diseased than in the sound, but the minimum is lower also, so that *the fact of a potato being diseased does not seem to indicate any fixed proportion of water. It may be as low as* 71 *per cent. or as high as* 82.

The necessity of numerous experiments in order to arrive at the truth, is shewn by the last set of determinations in the table —those upon the pink-eyed kidney. Had none been made but upon this kind of potato, we might have said that diseased potatoes, or parts of potatoes, contained much more water than such as are sound. It is only the trials made upon other varieties that shew how erroneous such a general conclusion would have been, and lead us to attribute the difference in the case of the pink-eyed kidney to the circumstance that the seat of the disease happened to be in the wetter end of this peculiar potato.

LABORATORY OF THE AGRICULTURAL CHEMISTRY ASSOCIATION.
12th February 1846.

ON THE ANALYSIS OF THE OAT.

By Mr John Pitkin Norton of Farmington, Connecticut.

[Premium Fifty Sovereigns.]

A chemical inquiry into the nature of the oat would be of importance in almost any part of Europe, but it becomes a kind of national object in a country where, as in Scotland, oatmeal forms almost the sole food of a large portion of the population. But though Scotchmen have long fed and thriven upon it, and have carried their estimation of its virtues to every quarter of the globe where their adventurous footsteps have penetrated, the true properties of the oat, its chemical constituents, the physiology of its growth, have been almost unnoticed. The few investigations hitherto published have been of a partial character. Hermbstädt and Sprengel were among the first who made experiments on the subject at all worthy of confidence. More lately Boussingault has published a single analysis; but no researches of an extended nature have hitherto been published.

To the Highland and Agricultural Society belongs the honour of first encouraging an extended inquiry for the purpose of increasing our knowledge as to the general value of the oat, as food for man and beast, and as to other points, physiological and practical, connected with its growth and cultivation. The encouragement of such researches is well calculated to retain for the Society its high position, and if possible to increase the estimation in which it is held, as the parent of the Agricultural Societies in the British Islands.

In the laboratory of the Agricultural Chemistry Association, I have enjoyed great advantages for the prosecution of such an investigation. The kindness of Professor Johnston afforded me every facility, while his great experience pointed out the proper method for the prosecution of my inquiries.

In the detail of my results I have endeavoured so to arrange them as to present a distinct connected view of the whole investigation, such as is necessary for its full appreciation. I have commenced with that which naturally comes first, the young plant, and have followed it through its successive stages of growth and development to maturity. This part of the subject completed, I shall proceed to the consideration of the full-grown plant.

I.—Of the Unripe Plant.

Through the kindness of my friend Mr J. Girdwood of Featherhall, Corstorphine, I was enabled to obtain during the past season, at intervals of a week, specimens of the young corn, cut always from the same spot in the field, and forwarded so as to reach me in a perfectly fresh condition.

I must here express my very great obligations to Mr Fromberg, first assistant in the Laboratory of the Agricultural Chemistry Association, to whom I am indebted for nearly all the results connected with the unripe plant. Early last spring, he undertook this part of the investigation, at the request of Professor Johnston, and has devoted much of his time to it during the past season. I am thus enabled to render my paper far more complete than it could otherwise have been.

A—*Of the Quantity of Ash yielded by the several parts of the Unripe Plant.*

As soon as the plants were received, portions of the several parts were weighed for the purpose of determining the water, and dried at a temperature not exceeding 212° Fahrenheit, until their weight became constant. At least three separate portions of each part were taken to provide for accidents, and to secure at least two concurring determinations.

While the above were drying, others were weighed from which to determine the ash. The burning was always effected in platinum vessels over argand gas-burners, and at a dull red heat.

The first specimens of the young plant arrived on the 4th of June, and the succession at weekly intervals was uninterrupted until the cutting of the crop on the 3d of September. The oats were of the potato variety, and though retarded by the unusually wet season, were uniformly strong and healthy, the sample proving one of uncommon excellence. The plants on the 4th of June were from 4 to 6 inches in height, consisting merely of one leaf, and the commencement of the stalk. These two parts, therefore, are first to be considered, as to the quantity of ash which they yield.

1.—*Of the Leaf.*

The following Table exhibits the proportions in the leaf at successive stages of its growth—1. Of Water. 2. Of Ash. 3. Of Ash calculated dry.

TABLE 1.

Day of the Month received.	June 4.	June 11.	June 18.	June 25.	July 2.	July 9.	July 16.	July 23.	July 30.	Aug. 6.	Aug. 13.	Aug. 20.	Aug 27.	Sept. 3
Per cent of Water, . . .	80.51	82.76	82 02	78.53	80.26	76.97	76.53	77.61	77 00	76.63	74.06	79.93	70.68	24.60
Per cent of Ash, . . .	2.16	1.86	1.63	2.35	2.24	2.81	3.06	3.85	3.78	3.75	6.14	4.25	6.49	15.78
Do. calculated dry, . . .	10.83	10.79	9.07	10.95	11.35	12.20	12.61	16.45	16.41	16.05	20.47	21.14	22.13	20.90

During the whole growth of the plant the diminution in the quantity of water in the leaf was not great, being only about 10 per cent from the 4th of June to the 27th of August. So late as the 20th of August it was nearly as high as at first. When the plant becomes ripe, however, the leaf at once withers, and this accounts for the great decrease of water between the 27th of August and the 3d of September. This decrease in the water gives a great apparent increase of ash in the undried leaf. When calculated dry, in the third line, there appears an actual decrease from the two preceding weeks. There may have been some change in the circulation at the last, by which a portion of the inorganic materials were carried back into the stalk.

2.—*Of the Stalk.*

The per-centages of Water, of Ash, and of Ash calculated dry, were determined as in the leaf.

TABLE 2.

Day of the Month received.	June 4.	June 11.	June 18.	June 25.	July 2.	July 9	July 16.	July 23.	July 30.	Aug. 6.	Aug. 13	Aug. 20.	Aug. 27.	Sept. 3.
Per cent of Water, . . .	87.04	87.05	87.13	84.74	83.66	82.05	80.85	79.60	76.64	75.66	69.80	76.27	71.57	71.70
Per cent of Ash, . . .	1.36	1.28	1.28	1.40	1.28	1.40	1.52	1.63	1.74	2.01	2 00	1.58	2.19	2.36
Do. calculated dry, . . .	10.49	9.88	9.32	9.17	7.83	7.80	7.94	7.99	7.45	7.63	6.62	6.66	7.71	8.35

The decrease of water during the growth of this part is considerably more than in the leaf. The quantity of ash in the undried straw (second line) increases toward the end, as in the undried leaf. This, in both cases, is owing to the gradual disappearance of the water; for we see, in the third line, that the actual per-centage of ash in the *dried* stalk is less on the 3d of September than it was on the 4th of June. In the earlier growth of the stalk the dried stem or solid part, though less in quantity, actually contains a larger per-centage of ash than is afterwards necessary to its perfect maturity. As the stalk is the stem of the plant, through it must pass the inorganic materials necessary for the building up of all the other parts. How wise the provision, which enables it to furnish an abundance of these materials at the time when they are most needed! Between the 6th and the 27th of August the demand upon the straw was very great; at this period the grain was most rapidly attaining its full size; the leaf also between the 13th and the 20th of August increased its percentage of ash from 16 to 21. When these parts have attained their full size, and approach maturity, the ash in the stalk begins to accumulate again, as is seen in the two last weeks. This is at the same time that the decrease in the leaf mentioned above takes place.

From the very large per-centage of water in the stalk on the 3d of September, when the oats were cut, it is evident that there must be an immense diminution during the drying of harvest, as I have seldom found more than 13 or 14 per cent of water in straw taken from a well-made stack. This will appear in a subsequent table.

3.—*Of the Quantity of Ash in the Knots.*

It was not until the 23d of July that determinations of ash and water in the knots were commenced. Professor Johnston has stated in his Elements of Agricultural Chemistry, some curious facts respecting the knots in the stalks of wheat, rye, bamboo, &c. He says, that the ash of this part is larger in quantity, and contains a greater proportion of silica, which in the bamboo is sometimes found in solid masses. To ascertain if the quantity of ash in the knots of oats varied greatly from that in the whole straw, these trials were made.

TABLE 3.

Day of the Month received,	July 23	July 30	Aug 6	Aug. 13.	Aug 20	Aug 27	Sept 3.
Per cent of Water,	76 05	75 54	74 82	75 29	75 38	73 55	70 65
Per cent of Ash,	2 40	2 54	2 63	2 80	2 90	2 98	3 14
Do calculated dry.	10 02	9 60	10 44	10 48	11 79	11 27	10 70

The variation in the per-centage of water in this table is not large. The ash is, in accordance with Professor Johnston's results, larger in quantity than in the straw, taken as a whole. The difference in the ripe plant amounts to 2 per cent. But in Table 2 the ash is given from the *whole straw*, including the knots; the difference therefore between the knots and the straw, taken separately, would be at least 4 per cent. The variations in the per-centage of ash, shown by the above table, are not very striking.

4.—*Of the Quantity of Ash in the Chaff.*

The determinations of ash and water in this part of the plant commenced on the 16th of July. I must here mention, that by the chaff I mean the outer covering which envelopes the oat during its growth, becoming looser as it ripens, and finally falling off during thrashing.

Per-centage of Ash and Water exhibited as before.

TABLE 4.

Day of the Month received	July 16.	July 23.	July 30.	Aug. 6.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.
Per cent of Water,	55.01	56.95	50.49	45.04	40.86	47 08	40.44	21 96
Per cent of Ash,	2.72	3.92	6.08	7.83	11.05	11.20	13.38	21.43
Do. calculated dry,	6.00	9.11	12.28	13.75	18.68	21.07	22.46	27.47

The quantity of water given by the above table is much less, while that of ash is much greater, than in any other part of the unripe plant. The extraordinary quantity of 27 per cent, as given in the third line, is very remarkable. It is to be observed, however, that in no other specimen of chaff have I found so high a per-centage. The crop, as I have before stated, was unusually vigorous, and grown on a deep rich loam, where every thing it required seems to have been in abundance, and the per-centage of ash in every part is uncommonly large. It will be noticed that the increase of ash is more steadily progressive than in any of the other parts.

5.—*Of the Quantity of Ash in the Oat.*

It is necessary for me here to explain, that, in speaking of the *Oat*, I always mean the seed and husk together. By the *Grain*, I mean the seed divested of its husk. This distinction will prevent confusion. The oats did not become sufficiently developed for separation from the stalk until the 2d of July. The same treatment was pursued as with the other parts, and the following table exhibits the results.

TABLE 5.

Day of the Month received.	July 2.	July 9.	July 16.	July 23.	July 30.	Aug. 6.	Aug. 13	Aug. 20.	Aug. 27.	Sept. 3.
Per cent of Water,	80.84	75 56	69 83	63 22	62 06	62 44	55.11	49.76	45 92	30 74
Per cent of Ash,	0.94	1 02	1.17	1.33	1.60	1.62	1 87	1.83	1.90	2.53
Do. calculated dry,	4.91	4 36	3.38	3.62	4.22	4 31	4 07	3 64	3 51	3 65

During the growth of this part of the plant, the per-centage of water steadily decreased to considerably less than one-half of the original quantity. As in the stalk, this has caused an apparent increase of ash (second line), but when calculated dry (third line), there is an actual decrease. This diminution of ash occurs only in these two parts of the plant. I have already given a probable explanation of the cause in the stalk, and think that one equally simple may be given as to the oat itself. Every one who has noticed its growth, knows that the husk, being necessary for the protection of the grain, is formed first, and attains nearly its full size while the grain is yet scarcely visible. A subsequent table will show that the husk contains about three times as much ash as the grain. During the first growth of the oat, this husk, requiring an abundance of inorganic materials, is to be formed, and we accordingly find such a proportion of these materials present, as are not found at any subsequent period. When the husk is formed the grain enlarges, and as it gradually becomes three-fourths of the oat, the per-centage of ash, taking the two together, of course diminishes. By reference to Table 2 it will be seen, that on the 2d of July, just when the oat began to show itself, a sudden decrease took place in the ash of the stalk. The per-centage of water in the oats when the crop was cut, on the 3d of September, was more than twice as much as I have found in those taken from the granary or stack-yard.

Heretofore I have only spoken of the quantity of ash yielded by the several parts of the plant; I now would direct attention to the composition of this ash, which will constitute the second division.

B—*Of the Quality of the Ash from the several parts above mentioned.*

This series of analysis by Mr Fromberg, has already involved a very great amount of labour, and is not yet by any means finished, extending only over 7 weeks of the 14, in which the determinations of the quantity of ash were made. They extend to the 16th of July; and, so far as they go, present a complete view

of the curious and interesting changes which take place during the development of the various parts of the plant. As before, I will place the leaf first.

1.—*Composition of Ash from the Leaf of Unripe Oats at different periods of growth.*

TABLE 6.

Day of the Month received.	June 4.	June 11.	June 18.	June 25.	July 2.	July 9.	July 16.
Potash and Soda, .	24.60	23.51	26.21	28.10	18.78	16.09	18.35
Chloride of Sodium, .	16.34	13.54	11.30	7.56	7.92	4.09	0.30
Lime, . . .	8.44	7 21	7.33	6.74	6.91	5.93	5.13
Magnesia, . . .	5 33	3 11	3.47	3 06	2.39	2.35	1.63
Oxide of Iron, . .	0.61	0.52	0.72	0 99	0.40	0.34	0.55
Sulphuric Acid, . .	11.74	12 85	10.59	7.68	9.50	6.45	13.05
Phosphoric Acid, . .	16.16	10.57	10.12	8 76	6.92	6.44	2 91
Silica, . . .	16.58	28.54	30.31	36.50	47.62	58.28	58.22
	99.80	99.88	100.05	99.59	100.14	99.97	100.14

Perhaps the most striking feature in this table is the gradual disappearance of the chloride of sodium (common salt); from 16 per cent, in 7 weeks it decreased to less than a third of a per cent. A large quantity of soda yet remains, nearly all in the state of sulphate, no doubt. The phosphoric acid, too, disappears in a great degree. There were at first probably phosphates of potash and soda, but these must have left the leaf to supply the grain, and on the 16th July the small quantity of phosphoric acid left was nearly all in combination with lime, magnesia, and iron. The oxide of iron seems to have fluctuated in its proportions less than any of the other substances.

2.—*Of the Composition of Ash from the Stalks of the Unripe Plant.*

TABLE 7.

	June 4.	June 11	June 18.	June 25.	July 2.	July 9.	July 16.
Potash and Soda, . .	24.94	21.45	26.49	28.86	36.26	30.10	42.43
Chloride of Sodium, .	32.66	34.65	24.94	24.57	11.62	17.82	4.46
Lime, . . .	2.40	4.22	3.74	2.42	2.64	1.60	4.12
Magnesia, . . .	0.88	3.20	2 20	2.58	1.17	2.27	1.47
Oxide of Iron, . .	0.39	0.30	0.40	0.58	0.88	0.68	0.62
Sulphuric Acid, . .	6.15	7.82	8.51	4.87	7.98	9.09	7.84
Phosphoric Acid, . .	16.15	13 96	12.55	7.81	2.21	5,57	6.31
Silica, . . .	16.29	14.32	20.41	28.08	36.64	32.39	34.85
	99.86	99.92	99.24	99.77	99.40	99.52	100.33

The decrease in the quantity of chloride of sodium is here also very remarkable, from 32½ to 4½ per cent. The phosphoric acid continued without much variation until the 25th June, when the oat itself began to form; by the 2d of July the oats had shot up from the stalk and become visible; in that week a marked and sudden decrease took place in the phosphoric acid. In the two succeeding weeks it began again to increase. No very great changes seem to have taken place in the other constituents, excepting the gradual increase of silica. The composition of the stalk on the 16th of July differs very greatly from that of a mature stalk, as will afterwards be seen. It was then still green and vigorous, growing rapidly, and serving as a canal for the conveyance of a great portion of their food to the other parts of the plant. The inorganic ingredients, therefore, might be expected to vary, as we see them, with the fluctuations of temperature more or less favourable to vegetable growth.

3.—*Composition of Ash from the whole Oat, at different periods of its growth.*

TABLE 8.

	July 2.	July 9	July 16
Potash and Soda, . .	32 92	31 31	31 37
Chloride of Sodium, .	10 37	8 10	0 61
Lime, . . .	2 70	5 40	6 76
Magnesia, . .	3 44	4 52	2 94
Oxide of Iron, . .	0 39	0 21	0 35
Sulphuric Acid, . .	10 35	12 78	16 42
Phosphoric Acid, . .	14 02	20 09	15 19
Silica, . . .	21 40	17 05	26 05
	98 59	99 46	99 69

During these three weeks the oat attained nearly its full length, but was yet quite green, and the grain had scarcely begun to form in the interior of the husk. The above table, therefore, only enables us to compare the earliest part of its growth with the latest as afterwards given. The diminution of chlorine is, however, to be noticed as very great in the short space of three weeks. I think the large quantity of sulphuric acid present at this time would have diminished, as I have seldom found so much in the ash of the ripe oat.

4.—*Comparative View of the Composition of the Ash from the Leaf, Stalk, Oat, Knots, and Chaff, on the 16th of July.*

TABLE 9.

	Leaf.	Stalk.	Knots.	Chaff.	Oat.
Potash and Soda,	18.35	42.43	39.21	15 39	31.37
Chloride of Sodium,	0 30	4 46	0.60	2 01	0.61
Lime, . .	5.13	4.12	4.75	4.58	6.76
Magnesia, . .	1.63	1 47	4.51	3.10	2.94
Oxide of Iron, .	0.55	0.62	1.02	1.50	0.35
Sulphuric Acid, .	13.05	7.84	27.94	9.90	16.42
Phosphoric Acid, .	2.91	6.31	9.03	7.26	15.19
Silica, . .	65.22	34.85	13.23	56.38	26.05
	100.14	100.33	100.29	100.12	99.69

On the 16th of July the plant was in the midst of its most rapid growth, and just half-way between the time when it appeared above ground in June, and when it was cut on the 3d of September. In a subsequent table will be found a comparison of the ash from these parts of the plant when fully matured.

5.—*Organic Constituents of the Unripe Plant.*

In connexion with the first chapter of my subject, I have hitherto said nothing of the organic constituents of the unripe plant. Mr Fromberg has determined the nitrogen in the unripe oat at six periods of its growth, and also when it had become fully ripe. The following table gives his results.

TABLE 10.

	July 16.	July 30.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Quite ripe
Per centage of Nitrogen in Undried Oat,	0.51	0.51	0.62	0.66	0.97	1.52	1.87
Do. do. in Dried Oat,	1.71	1.35	1.38	1.31	1.79	2.20	2.18
Do. do. of Protein Compounds in Undried Oat.	3.24	3 24	3.90	4.15	6.10	9.58	11.80
Do. of do. in Dried Oat,	10.75	8.50	8.69	8.25	11.26	13.84	13.72

The steady increase of nitrogen from the 30th of July is very striking. Had time permitted, it would have been of much interest to determine the other organic constituents, both proximate and ultimate. This tempting field we have been obliged to leave for future exploration. I now pass on to that part of the investigation upon which I have principally been myself engaged.

II.—Of the Ripe Plant.

It now remains to consider the plant in a state of maturity, both as to its inorganic and its organic constituents. To the inorganic part I shall first direct attention, and here, as in the first chapter, I shall take up different portions of the plant in succession.

1.— *Of the Ash yielded by the Straw.*

It has been shown by professor Johnston,* that the ash from the straw of all the corn crops varies in quantity at different heights of the same stalk. To ascertain the nature and extent of this variation in the oat straw I considered a point of importance, and to it I first directed my attention. Each straw was divided into three equal parts, the bottom, the middle, and the top. These were separately burned in the same manner, and with the same precautions as have already been described under the unripe plant, each burning being repeated until two or more trials were found to agree.†

The following table gives a comparative view of the per centage of ash in these three parts, from five different samples of straw. The ash is calculated dry, and the average per-centage of water given in the upper line.

Table 11.

Variety of Oat and Locality.	Hopeton, Hexham, Northumberland.	Hopeton, Kilwhiss, Fife.	Dun, Swanston, Edinburgh.	Potato, Hexham, Northumberland.	Sandy, Kilwhiss, Fife.
Average of Water, .	11.21	10.11	9.36	10.99	9.19
Per cent of Ash in Top Straw, ...	4.95	5.41	8.25	9.23	10.01
Do. do. in Middle Straw,	6.11	4.23	6.53	7.41	9.01
Do do. in Bottom Straw,	5.33	5.86	7.10	9.76	7.30

The above table establishes two facts. 1. That there is a great difference in the quantity of ash yielded by the same straw at

* See his *Elements*, p. 44.

† The straw of the ripe oat generally burns with difficulty, if the heat be too great it fuses, enveloping in a kind of glass some of the carbonaceous matter; it is then almost impossible to burn it white. I have often been obliged to burn samples for more than twenty-four hours. The addition of peroxide of mercury has been proposed, and would undoubtedly be effective in whitening the ash, but I have feared that it would decompose some of the chlorides, and have therefore not made use of it.

different heights. 2. That the ash yielded by the same part varies greatly in different specimens; and that this holds true even when the samples are of the same variety of oat, as is seen in the Hopeton oats above. Thus far the results of Professor Johnston are confirmed. There is not, however, a regular gradation in the quantity of ash, from the top downwards. In only one case, that of the Sandy Oats, is this gradation to be observed. It may be that, if I had taken but one straw at a time, and accurately divided it, the result would have been different. I am inclined to doubt this, however; for the straw of the oat crop is well known to be more irregular in quantity than that of any other corn crop; and Table 12 shows that the average quantity of its ash is equally variable: this variation may very probably extend to different parts of the same stalk. Even if the averages of the above parts are taken, we still find a great difference in the amount of ash.

The following table illustrates this.

Average per centage of Ash in Six Samples of Oat Straw.

TABLE 12.

Kind of Oats.	No. 1, Hopeton.	No. 2, Hopeton.	No. 3, Dun.	No. 4, Sandy.	No. 5, Potato.	No. 6. Potato.
Average per cent of Ash,	5.46	5 02	7 29	9.11	8 76	8.65

We see here a range of a little more than 4 from the lowest to the highest per centage. If there were 3000 lbs. of straw upon an acre, the difference between the weights of inorganic matter carried off by the two crops, Nos. 2 and 5, would amount to about 128 lbs. per acre. Though they do not exactly agree, yet there is a much nearer approach to agreement in the two samples of Hopeton Oats, and in the two samples of Potato Oats, seeming to indicate that the average quantities of ash are more nearly alike in the same variety. This is very singular if true, but needs further proof. If the average of the above six trials can be considered as a standard, the usual per-centage of ash in oat straw is about 7·50.

The foregoing points as to the quantity of ash, being, as I hope, now sufficiently distinct, I come to an inquiry of much importance; do these differences in the quantity extend to the quality of the ash also? I shall proceed to show—1. That the ash varies in quality at different heights of the same stalk. Dividing the straw

into three parts as above, and analysing the ash from each part separately, the results are as follows.*

Composition of Ash from Oat Straw at three different heights. Hopeton Oat from Mr Harbottle, Hexham, Northumberland.

TABLE 13.

	Top Straw.	Middle Straw	Bottom Straw.
Sulphuric Acid,	38 55	18 45	16 10
Chloride of Sodium (common salt),		3 03	15 36
Potash and Soda,		21 80	40 17
Phosphates of Lime, Magnesia, and Iron,	2 84	3 03	0 78
Lime,	7 02	7 23	6 06
Magnesia,	2 84	2 91	2 07
Oxide of Iron,	0 30	1 40	0 61
Soluble Silica,	5 13	7 34	5 03
Insoluble Silica,	43 31	33 14	12 29
	99 99	98 33	98 47

In reference to the above analyses, I wish to direct attention to several points.

* It is proper here to introduce a brief account of the method which I have followed in the analyses of these ashes.

I have always divided them into three portions. 1. That which was soluble in water; 2. That which was soluble in acid; 3. That which remained insoluble. It is not necessary here to enter upon a detail of the reasons for this division; suffice it to say, that it was made as being likely to throw light upon various physiological questions, connected with the mode of growth and the circulation of the plant. Each division was subject to analyses separately.

I. *The Watery Solution.*—This was first evaporated to dryness, heated to drive off organic matter, and weighed. To the dry mass water was then added, and a small portion always refused to re-dissolve. This was, in several instances, analysed, and found to be chiefly soluble silica. In my later analyses this was added to the acid solution, to save time.

To the re-dissolved part of the watery solution was added—

1. Nitrate of silver, to throw down the chlorine, the liquid being previously acidulated by nitric acid. The precipitate was collected, burned, and weighed, with the usual precautions.

2. The excess of silver having been thrown down by hydrochloric acid, and removed by filtration, nitrate of baryta was added to obtain the sulphuric acid. This precipitate was allowed to stand at least twelve hours before filtration

3. After removing the excess of baryta from the solution by sulphuric acid, hydrosulphuret of ammonia was added, to throw down the manganese.

The phosphoric acid was determined by the method of Berthier, well known to analytical chemists—an excellent method when the usual precautions are employed, and there is no iron in the solution.

5. The solution was next evaporated to dryness, and the sulphate of potash and soda weighed together, then re-dissolved, and the potash obtained by the bi-chloride of platinum. The precipitate, collected and weighed in the usual manner,

1. To the great difference in the proportion of salts soluble in water. Part of these are grouped together in the top straw analyses; with the addition of the soluble silica, their amount is 42 per cent, in the middle straw it is 55 per cent, in the bottom straw 77 per cent. The increase of these soluble salts, therefore, is very great as we proceed downwards, being nearly twice as much at the bottom as at the top.

2. To the abundance of sulphuric acid and the total absence of phosphoric acid in the watery solution.

3. That as the salts soluble in water increase from the top downwards, the silica increases from the bottom upwards. This seems to be an invariable law. The *quantity* of ash, as I have shown, varies, being sometimes greater in one part and sometimes in another; but whichever part this may be, whether the top or

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was calculated as sulphate; this, subtracted from the united weight of the sulphates as weighed above, gave the loss as sulphate of soda, from which the soda was calculated.

II. *The Acid Solution* —1. Ammonia was added to throw down the phosphates. The precipitate was always a mixture of phosphates of lime, magnesia, and iron. It was fused with carbonate of soda, the phosphoric acid determined by Berthier's method, and the lime, magnesia, &c., in the usual way. This method of analysing phosphates is by no means a perfect one, but with certain precautions very good results may be obtained. I have tried various other methods with bad success. One of these has been highly recommended; it is that of throwing down the phosphoric acid as a phosphate of the peroxide of iron, from a solution in acetic acid. The precipitate obtained is so variable in its composition, that it is always necessary to analyse it separately, and the whole process is so uncertain, that after many trials I abandoned it.

2. The lime was thrown down by oxalate of ammonia, and collected after standing at least twelve hours.

3. As I found, in almost every instance, potash and soda in this part of the acid solution, it became necessary to determine the magnesia in some other than the usual way, by phosphate of soda. The solution was therefore evaporated nearly to dryness, mixed with a little peroxide of mercury, and rather strongly heated. The chlorides of potassium and sodium decompose with great difficulty, and that of magnesia with ease; the latter was therefore by heating converted into caustic magnesia, and separated by washing with *boiling* water. The solution, containing the potash and soda, was now evaporated to dryness, and they were determined as above.

III. *The Insoluble Portion.*—1. This was fused with five times its weight of carbonate of soda, the fused mass dissolved in hydrochloric acid, and the silica obtained in the usual way.

2. The phosphates were precipitated by ammonia, and, after weighing, were analysed with the phosphates of the acid solution.

3. The lime was thrown down as usual by oxalate of ammonia, and the magnesia by phosphate of soda.

4. Potash and soda. A small quantity of potash and soda is often present even in the insoluble part of the ash, and I have, therefore, in many cases been obliged to determine it by fusing with baryta in the ordinary way.

The above is an outline of a complete analysis, according to the methods I have generally pursued, supposing all the substances mentioned to be present Of course their presence or absence was previously ascertained by a qualitative examination, and the analysis modified accordingly. The quantity I considered proper for analysis was from 20 to 30 grains.

the bottom has most *ash*, in *every* case that I have examined, the top has the most silica, and the bottom the most salts soluble in water.

Having thus shown that different parts of the same stiaw vary, I proceed to prove, in the second place, that the same parts vary in different straws. In order to make my results bear upon as many questions as possible, I have selected two samples of the same variety of oats, grown on two widely different soils. No. 1. was from a light rather sandy loam, of good quality. No. 2. was from a poor mossy soil, where the great difficulty is to make the straw stand.

Table, giving the composition of Ash from Straw of two specimens of Hopeton Oats.

TABLE 14.

	No 1, Top Straw	No 2, Top Straw.	No 1, Middle Straw	No 2, Middle Straw	No 1 Bottom Straw	No 2 Bottom Straw
Salts soluble in water, chiefly Sulphates and Chlorides,	41 96	71 70	55 22	84 03	77 46	90 26
Phosphates of Lime, Magnesia, and Iron,	2 94	0 77	3 03	1 51	0 78	2 21
Lime and Magnesia,	11 29	14 34	9 70	8 73	9 16	2 65
Silica, .	43 75	13 18	32 05	5 72	12 55	4 86
	99 94	99 99	100 00	99 99	99 95	99 98

On comparison of the above analyses, it is first to be noticed, that there is an extraordinary difference in the per-centage of salts soluble in water, in each part of the two samples. The top straw and middle straw of No. 2. each contain about 30 per cent more than the corresponding portions of No. 1.

2. That this difference is equally great as to the silica.

3. That the lime and magnesia also in both instances are greatest in the top straw.

This table may be considered a very excellent illustration of the extent to which the soil modifies the composition of the ash. No. 1. is a fair example of a healthy straw. No. 2, being the same variety of oat, has been grown where its wants were not fully supplied. I have said that on the mossy soil from which this sample came, the great difficulty was to make the straw stand. The above analysis shows that a want of silica was probably the cause of this difficulty. It is a curious fact in accordance with the above, that the addition of a very fine siliceous sand to some places on this soil has in a great degree remedied this weakness

of straw. The abundance of alkalis present in the soil, judging from the quantity in the above ash, may facilitate the solution of this finely divided silica. The *quantity* of ash in the two samples does not greatly differ,—see Table 6. No. 2 seems to have endeavoured to supply the want of silica by potash and soda. Sprengel has made an analysis of ash from oat straw; but his results differ much from mine. He gives for instance 80 per cent of silica. Fifty per cent is the largest quantity I have observed even in the top straw. The variations that I have found are, however, so great, that I hesitate to pronounce his analysis erroneous. Some peculiar circumstances may have caused the presence of even this extraordinary quantity.

Before leaving for the present the subject of the straw, I may mention, that I have, so far as my time permitted, turned my attention to the disease called the *Smut* in oats, and have several analyses of ash from the smutted straw. I regret much that they are not in a sufficiently advanced state for publication. So far as they go, they indicate a derangement in the circulation of the plant, especially in the top straw.

The following comparison will show that in *quantity* the ash does not materially differ from that of the healthy straw.

TABLE 15.

Per cent of Ash	Top Straw.	Middle Straw.	Bottom Straw
From Healthy Straw,	5 64	7 89	9 17
From Smutted Straw,	6 52	6 10	7 78

2.—*Of the Ash yielded by the Leaf.*

This part of the plant, though it withers away, and seems of little consequence when the corn is ripe, is yet of vital importance during its growth, and therefore demands our attentive consideration.

It yields more ash than the straw, in some cases fully twice as much; and this ash, like that of the straw, varies in quantity with the soil, the manure, and the variety of oat.

The following table gives the per-centage of ash and of water, in six samples of leaf. The ash is, as usual, calculated dry.

TABLE 16.

Per centage	Hopeton Oats.		Dun Oats.	Sandy Oats	Potato Oats.		Mean of Trials.
	No 1.	No 2			No. 1.	No. 2	
Of Water, .	9 03	9 57	10 11	10 95	10 33	11 02	10 14
Of Ash, . .	7 19	8 44	10 29	14 79	14 59	20 90	12 70

In this table are differences much greater than those which appeared in the straw. The leaf from the potato oat No. 2, has nearly three times the per-centage of ash yielded by that from the Hopeton oat No. 1. The potato oat leaf came from an extraordinary crop on a rich loam; the Hopeton oat leaf from a very inferior straw on a poor soil.

In separating the leaf from the stalk, I took the whole leaf from the knot to which the bottom is attached, thus including the part which wraps around the stalk.

It occurred to me that there might be a difference in the quantity of ash yielded by this latter part, compared with that portion of the leaf which projects from the stalk. I accordingly separated the leaf of a Sandy oat into two parts, and separately determined the ash with the following result.

TABLE 17.

	Ash calculated dry.
Ash from Top of the Leaf,	16 22
Do from Bottom,	13 66

This difference in the quantity of these two ashes, is what we should have been led to expect from the previous determinations of ash in the straw, where it was in a majority of cases most abundant at the top.

There are fewer disturbing causes in the circulation of the leaf than in that of the straw, and we may perhaps rely with more certainty on a regular gradation of ash from the top to the bottom.

The quality of the ash from the leaf differs from that of the straw. The following extended analysis is of the ash from what may be considered a fair specimen of a healthy leaf, neither excessively luxuriant, nor at all stinted in its growth. It is from the same Hopeton oat of which the straw ash analyses were given in Table 13.

Composition of Ash from the Leaf of Hopeton Oats, from Mr Harbottle, Hexham, Northumberland.

TABLE 18.

	Per centage
Sulphuric Acid,	14 80
Caloride of Sodium (common salt,)	2 29
Potash, Soda,	14 89
Phosphates of Lime, Magnesia, and Iron,	6 13
Lime,	6 99
Magnesia,	2 55
Soluble Silica,	5 90
Insoluble Silica,	45 75
	99 30

The watery solution contained about 37 per cent of this ash, and from the above amount of sulphuric acid, it is quite plain that about 30 per cent were sulphates. The soluble and insoluble silica together constitute more than half of the ash.

The leaf acts a most important part in the economy of the plant; the organic food which is derived from the atmosphere is absorbed through the pores of the leaf. In order to perform this function, it must spread out a broad expanded surface, which will come in contact with as much as possible of the surrounding air. This leaf, so extended and yet so thin, requires a degree of stiffness that it may stand forth from the stalk, and wave in the breeze, rather than hang helplessly down as if withered. For this purpose a strong framework must be furnished. In Table 16 the average per centage of ash from six samples of leaf, is 12½, and of this fully one-half is silica. It is, I think, not unnatural to conclude that this large quantity of ash, so great a part of which is silica, is conveyed to the leaf for the purpose to which I have alluded. When the plant is uncommonly vigorous, and the leaf expands to an unusual breadth, this framework (see Table 16) may amount to even 20 per cent.

I have now to show that the ash of the leaf varies in quality as well as quantity, and for this end give the three following analyses.

Composition of Ash from three samples of the Oat Leaf.

TABLE 19.

	Hopeton Oats		Sandy Oats. Gravelly Loam
	1 Light Loam.	2 New Moss.	
Salts soluble in water, chiefly Sulphates and Chlorides,	36 77	56 5	45 77
Phosphates of Lime, Magnesia, and Iron,	7 23	3 66	1 00
Lime and Magnesia,	10 24	1 33	3 27
Silica,	45 75	38 5	49 96
	99 99	99 99	100 00

The general composition of the ash from the leaf does not greatly differ from that of some samples of top straw. To the insoluble silica, in the lower line of the above, must be added, in each case, 4 or 5 per cent of soluble silica included in the watery solution.

Having found that the top and bottom of the leaf yielded different quantities, I was desirous of further ascertaining if the quality differed also. The following table gives analyses of the ash from the two parts.

TABLE 20.

	Ash from Top of Leaf	Ash from Bottom of Leaf.
Salts soluble in water, chiefly Sulphates and Chlorides,	43 26	48 28
Phosphates of Lime, Magnesia, and Iron,	0 85	1 15
Lime and Magnesia,	3 76	2 78
Silica,	52 13	47 79
	100 00	100 00

The differences of composition in these two ashes are of the same character as those which have been noticed in the straw. Though not so striking as those differences, they show that the same rule as to the preponderance of silica at the top, and of soluble salts at the bottom, holds true in both these parts of the plant.

3.—*Of the Ash yielded by the Chaff.*

The chaff forms a very small and seemingly unimportant part

of the plant, but it is in reality indispensable to its perfection, and a close examination shows that it is admirably adapted to its particular end.

1. The quantity of ash which it yields is greater than that left by any other part, and as in the other parts, this quantity varies with the soil and with the variety of oat.

The following table exhibits the per centage of ash and water, in seven specimens of chaff.

TABLE 21.

	Hopeton Oats.			Sandy Oats.	Dun Oats.	Potato Oats.		Mean of Seven Trials.
	No. 1.	No. 2.	No. 3.			No. 1.	No. 2.	
Per centage of Water, .	10.28	10.69	10 58	9 60	11.62	11.16	10.95	10.69
Do of Ash, calculated dry,	7.23	10 69	16.53	18 97	19.16	18.59	27.47	16 94

It is singular that the per centage of water in the thin, dry, light chaff, should be fully equal to that in the straw.

The average of the above is nearly 17 per cent; as this is higher than that of any other part, so no other exhibits so wide a range. The chaff of potato oat, No. 2, has nearly four times as much ash as that of Hopeton oat, No. 1. This last-mentioned chaff is from the sample of oats I have noticed before, as grown on a poor mossy soil.

2. The quality of the ash from the chaff also varies greatly in different samples, and its composition suggests some interesting inquiries. As before, I will give an extended analysis first.

Composition of Ash from Chaff of Hopeton Oat, from Mr Harbottle, Hexham, Northumberland.

TABLE 22.

	Per centage.
Sulphuric Acid, ...	5.32
Chloride of Sodium (common salt), .	5.11
Potash, ... } Soda, ... }	7.96
Phosphates of Lime, Magnesia, and Iron,	5.84
Lime, ...	4.55
Magnesia, ...	1.84
Soluble Silica, ...	11.99
Insoluble Silica, ...	56.05
	98.66

The quantity of silica in this ash amounts to nearly 70 per cent, being much greater than in any ash that I have before instanced. There is an extraordinary quantity of soluble silica in this chaff, and it may probably in this respect be considered an extreme case, for I have not found so much in any other sample.*

The office of the chaff seems to be to protect the oat during the earlier stages of its growth. For this reason fully one-sixth of its weight is ash, and of this ash 70 per cent is silica. While the husk is yet soft and green, the chaff has arrived nearly at maturity, and closely envelops the tender seed with its flinty covering. As the husk gradually hardens, the chaff unfolds, and at last leaves the grain entirely to this its ultimate protector.

3. It now remains to show that the chaff varies in quality as well as quantity. The above single analysis must not be considered as a standard for the composition of the ash in other samples, it only indicates its leading features. The four following analyses, on a less extended scale, will be found to present variations equally extensive with those we have noticed in the other parts of the plant.

Composition of Ash from four specimens of Chaff.

TABLE 23.

	Hopeton Oats		Potato Oats, Gravelly Soil	Dun Oats, Good Loam
	No 1, Light Barley Soil	No 2, Poor Moss		
Salts soluble in water, chiefly Sulphates and Chlorides, .	35 02	34 12	19 86	18 66
Phosphates of Lime, Magnesia, and Iron,	4 29	8 73	2 26	2 40
Lime and Magnesia,	4 03	7 14	7 01	4 44
Silica, . . .	56 65	50 01	70 86	74 50
	99 99	100 00	99 99	100 00

The soluble silica, here included in the salts soluble in water, is to be added to the insoluble silica. With this addition, the silica in the last sample amounts to about 80 per cent. The Hopeton chaff, No. 2, is from the same mossy land which I have noticed in all the other parts as deficient in silica. In the chaff

* I have taken many precautions in my determinations of soluble silica; in the above instance the quantity was so large, that I fused the substance obtained with carbonate of soda, and confirmed my previous result. I was at first accustomed to burn and weigh, before treating with acid, that portion of the watery solution which refused to redissolve after evaporation to dryness; but latterly, fearing that by burning some alkaline silicates might be formed, insoluble even in strong acid, I added the acid to the undissolved portion before burning.

and leaf, however, this deficiency is not so great as in the straw; a subsequent table, No. 30, will show that the husk also has nearly its full proportion. This partiality, as it may be called, in the distribution of silica, I have noticed in several other analyses of the various parts. The leaf must have its framework to sustain it, while drawing food for the whole plant from the atmosphere; the chaff must have a large quantity of silica to form an effective covering for the tender oat; and the husk also must in its turn be fitted to protect the grain through all vicissitudes, until it is committed to the earth, and has commenced its growth. We find it actually the fact, that these parts are better supplied than the stalk, a part which can better perform its functions with a small supply than any other. Are we not then justified in supposing that some law exists by which those parts, where a particular substance is most needed, are supplied, even to the deprivation of other parts which can *exist* with a smaller quantity? Nature thus does all in her power towards the complete performance of her duties. She labours to perfect the leaf, the chaff, the husk, and through them finally the seed, upon which the future continuance of the species depends, if now the materials are exhausted, the straw must be weak and imperfect. *Nature* can do no more, the necessary substances are not within her reach, or she is prevented from obtaining them by the physical condition of the soil; the responsibility is thrown upon the cultivator, who has neglected his duty in the preparation of the soil, or in furnishing those substances which are essential to its fertility.

4. and 5.—*Of the Ash yielded by the Husk and the Grain.*

In the consideration of the *quantity* of the inorganic constituents of the husk and of the grain, I shall separate them as I have done the other parts of the plant. In the first place, however, I shall draw attention to some points in which comparisons of the two parts are involved.

1. I have thought it of some importance to ascertain the relative proportions of husk and grain in different samples of oats, with the view of determining whether this might be an index of quality.

The following table gives these proportions in nine samples of Oats.

TABLE 24.

	Hopeton Oats. No. 1.	Hopeton Oats. No. 2.	Hopeton Oats. No. 3.	Hopeton Oats. No. 4.	Potato Oats.	Dun Oats.	Victoria Oats.	Black Tartary Oats.	Sandy Oats.
Grain in 100 parts,	76.4	77.99	77.39	74.26	76.80	76.28	71.86	72.38	76.28
Husk in 100 parts,	23.42	22.0	22.61	25.55	23.20	23.66	28.22	27.62	23.68

An average of the above gives 75·54 as the usual proportion of grain, and 24·26 of husk. I am inclined to think that this separation cannot be considered a *certain* indication as to quality, because the above Victoria oat, which afforded the largest per centage of husk, was sent as a sample of peculiar excellence, having yielded an extraordinary quantity of fine meal to the boll. The thinness of the skin, in this instance, was more than an equivalent for the thickness of the husk.

2. Of the water in the oat at ordinary temperatures, the annexed table gives the per centage in five of the ordinary varieties.

TABLE 25.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Per centage of Water,	13.02	13.59	11.02	11.50	11.90

The mean of the above gives about 12 lbs. of water in 100, or about 5 lbs. in a bushel of oats, as they are when kept in a dry place at the ordinary temperature. This is probably somewhat below the true average, as my determinations were made upon oats that had been kept for some time in small parcels.

I was next desirous to ascertain how much of this water was contained in the grain, and in the husk respectively, and accordingly made trials of each part separately. The following table contains my results.

TABLE 26.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Per cent of water in grain, .	13.17	13 66	11.06	11.27	11.56	12.10
Do. do. in husk, .	12.55	13.38	10.19	10.09	11.52	11.09

The difference is not great. It is singular that the husk should contain so very nearly the same per centage as the grain, a body we should suppose so much more suited to absorb and retain water. The chaff, as we have seen, presents an analogous case.

3. The next inquiry relates to the quantity of ash, and is of much importance. I am now to show that in these two parts of the plant, the ash varies in quantity under different circumstances of growth, as we have found it to do in the parts already examined. I shall first give the husk and grain separately, and then the quantity yielded by the whole oat.

The annexed table gives the per centage of ash in the dry husk and grain of different varieties of oats, grown on unlike soils.

TABLE 27.

Kind of Oats.	Hopeton, Light Loam	Hopeton, poor Moss.	Hopeton, Lime-sick land.	Hopeton reclaimed Moss.	Potato, thin Gravel.	Dun,good Loam.	Sandy gravelly Loam.	Mean of seven trials.
Ash in Grain.	2.14	2.81	2.28	2.32	2.22	2.11	1.61	2.07
Ash in Husk.	6.47	5.27	6.49	7.11	6.99	8.24	6.03	6.66

It appears from the mean of the above trials that the husk contains three times as much ash as the grain. The variations of ash in the different samples of each are not so wide as in other parts of the plant, but there are no two even of the same variety alike.*

The following table gives the per centage of ash in the whole oat.

TABLE 28.

	No. 1.	No. 2.	No 3.	No. 4.	No 5	No. 6.	No. 7.	No. 8.	Mean of eight trials
Per cent of ash in whole oat, calculated dry	3.17	3.32	3.37	3.25	3.56	2.58	2.66	3.65	3.19

If we take the above mean as near the true one, the bushel of 40 lbs. contains nearly 1¼ lbs. of ash; a crop of 60 bushels, therefore, carries off about 75 lbs. When the whole oat is burned, we find that the grain being in so much larger quantity, brings down the united per centage of ash far below what is yielded by the husk alone.

* The grain burns with exceeding difficulty. The abundance of alkaline salts is so great that it is almost impossible to prevent their melting, and enveloping the carbonaceous matter. I have, in some instances, been compelled, after charring the grain, to dissolve out these phosphates, by boiling in successive portions of distilled water. The remaining ash then burns white. The alkaline solution is again added, and the whole evaporated to dryness. This method, *with care*, is perfectly accurate.

Having now completed these preliminary inquiries, I turn to the consideration of the composition of the ash from the husk and the grain.

I shall now separate the two parts, and give the analysis of each in a distinct table.

1.—*Composition of the Ash from the Husk.*

I have already shown that the ash of this part is three times greater in quantity than that of the grain, and that it constitutes about the third part of that which is taken from the land in the seed. In proceeding another step, and ascertaining its composition, I shall first direct attention to a table containing extended analyses of the ash from four specimens, grown in widely separated parts of the country, and of the two most common varieties, the Hopeton and the potato oats.*

TABLE 29.

	Potato oats, Northumberland.	Hopeton oats.		
		No 1, Northumberland.	No 2, Wigtonshire	No 3, Ayrshire.
Sulphuric acid	4 30	9 61	5 01	4.90
Phosphoric acid	0 66	1.04	2.65	1.80
Chloride of sodium, (com. salt)	2.39	0.24	...	...
Chloride of potassium . . .	...	...	2 37	0.40
Potash	2.23	3.93	5.55	5.30
Soda	8 97	6 33	...	...
Lime	4.30	1.95	4 31	2.03
Magnesia	2.35	0.38	1.01	0.64
Peroxide of iron	0.32	1.58	1 61	1.80
Peroxide of manganese . .	...	0.92	0 86	0.72
Soluble silica	5 79	4.46	2.91	1.61
Insoluble silica	68.39	68.39	71 82	80.11
	99.80	98.83	98.10 F	99.33 F

The very large per centage of silica is one of the most striking features in this table. It amounts in every case to more than 70, and in Hopeton oats, No. 3, to more than 80 per cent, averaging considerably higher than in any other part of the plant. It is no doubt present in such quantity that the husk may be a proper covering to the grain. While the husk is yet green, the chaff, as I have stated, protects both it and the grain; but this is only until the husk arrives at maturity; it is then, by itself, admirably fitted to protect the grain, and the chaff is no longer necessary.

* The analyses marked F, are by Mr Fromberg.

In the salts soluble in water, sulphuric acid still predominates; phosphoric acid is usually there also, but in minute quantities, and the phosphates in the acid solution seldom amount to more than 1 or 2 per cent. In two of these analyses there is no soda, neither is it found in the ash from the grain of the same oats. The two alkalies seem to fulfil the same purpose in the economy of the plant, and it appears to take one or both indifferently, as they are more or less abundant in the soil.

The above table has shown that the ash of the husk varies in its composition, but I have prepared another in a condensed form, which exhibits the fact more distinctly.

Composition of Ash from four samples of Oat Husk.

TABLE 30.

	Hopeton oats.		Potato oats, Gravelly soil.	Dun oats, Good loam.
	No. 1, Light sandy loam.	No. 2, Poor moss.		
Salts soluble in water, chiefly Sulphates and Chlorides,	22.92	33.84	23.14	19.96
Phosphates of lime, magnesia, and iron	1.84	4.62	1.10	2.40
Lime and magnesia	6.79	1.54	5.18	3.28
Silica .	68.55	60.00	70.57	74.25
	100.00	100.00	99.99	99.98

To the insoluble silica in each of the above, must be added 4 or 5 per cent of soluble silica contained in the watery solution. The Hopeton oat husk, No. 2, on "poor moss," is the same to which I have referred before. It is less deficient in silica than any part of the plant to which it belongs. Its demands, as most imperative, seem to have been supplied first.

No part of the plant has so small a portion of salts soluble in water as the husk. From the instance of the Dun oat above, they may even be below 20 per cent in a perfectly healthy sample, for this was inferior to none in general appearance and size.

2.—*Composition of the Ash from the Grain.*

With this last part of the plant I shall follow the same plan as I have hitherto pursued, first giving extended analyses, and then directing attention to the differences caused by variety of soil, manure, &c.

TABLE 31.

	Potato oats, Northumberland.	Hopeton oats.		
		Northumberland.	Ayrshire.	Ayrshire.
Sulphuric acid	...	17.37	...	...
Phosphoric acid	49.19	38.48	46.26	50.44
Chloride of sodium, (com. salt)	0.35	0.49	...	...
Chloride of potassium	...	...	5.32	1.03
Potash } Soda }	31 56	20.96	16.27	20.65
			...	...
Lime	5 32	6.57	10.41	10.28
Magnesia	8.69	11.00	9.98	7.82
Peroxide of iron	0.88	0.38	5.08	3.85
Peroxide of manganese	...	...	1.25	0.42
Soluble silica	0 89	1.29	...	....
Insoluble silica	0.98	2.31	3.70	4.40
	97.86	98.85	98.27 F	98.39 F

In every part of the plant hitherto, we have found sulphuric acid in the watery solution of the ash; in the grain it seems to give way to phosphoric acid. In only one of the above analyses is it present; that grain was from a poor crop, grown on an exhausted soil, and it is possible that the sulphuric acid may have been present only because it was impossible to obtain a full supply of phosphoric acid.

The large quantity of this acid is remarkable; in nearly every case it constitutes almost or quite one-half of the ash. It is easy, therefore, to see how the addition of bones or guano should benefit the oat crop.

Silica, heretofore so prominent an ingredient in the ash, is here very small in quantity.

The second sample of Hopeton oats was grown on what is called lime-sick land, but it will be perceived that the proportion of lime is not larger than in some of the other ashes. This is in accordance with an opinion of Professor Johnston, first suggested after an analysis of a lime-sick soil, that the defect does not consist in a superabundance of lime, but in a physical condition of the soil, produced originally by too large a dose of lime at once. The oats from this soil were very poor, the grain full sized but light. The quantity of chlorine is large compared with the others, as is that of the oxide of iron also, otherwise there are no very striking differences.

The grain constitutes three-fourths of the weight of the oat, and furnishes a little more than one-half of the ash; in which ash, if we consider 45 lbs. of phosphoric acid the average, a crop of 60

bushels will carry off about 68 lbs. of that acid, equivalent to about 300 lbs. of bones.

From the many analyses of grain that I have made, I will only select three, in addition to those which I have already given.

The three samples of oats to which the grain belonged were obtained through the kindness of my friend Mr Simpson of Teawig, Beauly, Inverness. In accordance with my request, he selected specimens from the same neighbourhood, grown on very unlike soils. They were of crop 1844.

"No. 1. *Sandy Oats.*—Grown on a stiff clay soil, which was much *baked* by the early summer's drought. They were after grass sown with wheat laid down after a crop of turnips, manured with farm-yard dung and a small quantity of bones. Crop, 4 quarters per acre."

"No. 2. *Hopeton Oats.*—Grown on a poor sandy soil, which also suffered much from the drought. The oats were after two years' grass, pastured, the grass sown down with barley, after a turnip crop (raised with bones), which was all eaten off on the ground by sheep. Produce, *three quarters* per acre."

"No. 3. *Hopeton Oats.*—Grown on a deep rich vegetable mould, one of the best soils in that part of the country. Managed in the same manner as No. 1. Produce, *eight quarters* per acre."

I will first give the per centage of ash obtained from the grain of these oats, and then its composition.

Per centage of Ash in Grain, from Mr Simpson.

TABLE 32.

	No 1	No 2.	No 3.
Ash, calculated dry.	1.80	1.48	2.48

The differences in this table are certainly very striking; after the above account of the soils, and amount of the crops, they scarcely need any explanation. The poorest crop has least ash. This is a very decisive proof of the absolute necessity of this small portion of inorganic matter to the grain. The scanty supply yielded by the soil of No. 2 seems to have made a difference of 5 quarters per acre in the crop.

We will now consider the composition of these ashes, as given n the following table.

TABLE 33.

	No. 1.	No. 2.	No. 3.
Salts soluble in water, chiefly sulphates and chlorides, ...	68.52	70.96	72.96
Phosphates of lime, magnesia, and iron...	21.60	18.63	12.42
Lime and magnesia	7.10	7.11	11.95
Silica..	2.78	3.30	2.67
	100.00	99.99	100.00

The chief differences in these ashes are in the lime and magnesia, and in the phosphates. It seems strange that the latter should be least in the ash of No. 3. This would perhaps be explained by some local circumstances, with which I am not acquainted.

The quantity of silica, in the ash of No. 2, from the sandy soil, is, as we should expect, somewhat larger than in the others.

On the whole, the differences between these ashes, are not very striking, and it would be hard to say from an inspection of the above, which had belonged to a poor crop. This fact is most worthy of attention, since, in so far as the present analyses go, they show that the plant will only produce as many *seeds* as it can bring to perfection, so far as the inorganic part is concerned. It may, and will, as we have seen, produce an imperfect straw, but the essential parts of the ash of the *grain* must always be present, and that too in the proper proportions.

Before closing my account of the inorganic part of the oat, I will introduce two tables, the first of which gives a comparative view of the per centages of ash yielded by all the parts of the plant in different specimens, and the second an analyses of each of these parts united in one table, so as to give a comprehensive view of the whole.

1.—*Comparative view of the quantity of Ash yielded by the different parts of the Plant. Calculated dry.*

TABLE 34.

	Hopeton, Northumberland.	Hopeton, Fife.	Potato, Northumberland.	Dun, Edinburgh	Sandy, Fife.	Mean of each part.
Grain............	2.14	1.81	2.22	2.11	1.67	2 00
Husk	6 47	6.03	6.99	8.24	6.03	6.75
Chaff............	16.53	17.23	18.59	19.16	18.97	16.09
Leaf	8.44	7.19	14.59	10.29	15.92	10.88
Top straw......	4.95	5.44	9.22	8.25	11.01	7.77
Middle straw...	6.11	5.23	7.41	6.53	9.01	6.66
Bottom straw..	5.33	5.18	9.76	7.10	7.30	6.93

2.—*Comparative view of the Composition of Ash from each of the above parts in Hopeton Oats, from Mr Harbottle, Hexham, Northumberland.*

TABLE 35.

	Grain.	Husk.	Chaff.	Leaf.	Top Straw.	Middle Straw.	Bottom Straw
Sulphuric acid	......	9.61	5.32	14.60	16.33	18.45	13.29
Phosphoric acid	49.19	1.04	......	......	......	......	......
Chloride of sodium	0.35	0.24	5.11	2.29	3.13	3.03	15.36
Phosphates of lime, magnesia, and iron	......	......	5.84	6.13	2.84	3.03	0.78
Potash Soda	31.56	10.26	7.96	14.89	19.09	21.80	43.17
Lime	5.32	1.95	4.53	6.99	7.02	7.23	6 06
Magnesia	8.69	0.38	1.84	2.55	2.84	2.91	2.07
Peroxide of iron	0.88	1.58	0.24	......	0.30	1.40	0.61
Peroxide of manganese	......	0.92	......	......	......	......	......
Soluble silica	0.89	4.46	11.99	5.90	5.13	7.34	5.03
Insoluble silica	0.98	68 39	56.05	45.75	43.31	33.14	12.25
	97.86	98.63	98.90	99.30	99.99	98.33	98.35

Sprengel and Boussingault have published analyses of the grain of oats. Those of Sprengel are inserted in Professor Johnston's Lectures, and those of Boussingault in his own works. As all the results hitherto presented in this paper are original, I merely refer to these without introducing them.

I have now finished the course that I at first marked out for the inorganic division of this chapter. The plant has been divided into seven parts, the top, middle, and bottom straws, the leaf, the chaff, the husk, and the grain. The leaf was again subdivided into a bottom and top part. Of each of these nine parts it has been shown—

1. That it varies from every other, both in the quantity of its ash, and the composition of that ash.

2. That variations also exist between the ash from different specimens of the same part, grown on different soils.

3. That in these variations, although often very great, the distinctive character of the part is always preserved; the composition of the ash from the husk, for instance, never being like that from the straw or leaf.

4. That the soil has a direct influence on the quality of the ash. This has been proved in several instances, and particular deficiencies pointed out.

5. That each part is furnished with an ash—in quantity and quality peculiarly adapted to the function which the part is designed to fulfil.

The silica, for instance, is in the straw so distributed as most effectually to strengthen those parts which need its supporting

power; in the leaf it sustains an extended surface of pores in contact with the atmosphere; in the chaff it forms an impervious coating for the husk, until that part has also received a supply which enables it to protect the grain, upon which the perpetuation of the species depends.

Equally beautiful are the facts which we discover respecting the alkaline sulphates and phosphates. We find little of the latter in the whole length of the straw, in the leaf, or in the chaff. But when we arrive at the grain, the alkaline sulphates disappear, and the phosphates take their place; these have passed up the whole length of the stalk, avoiding the leaves and the chaff, and at last, by a law infinitely more unerring than any which human wisdom can devise, deposited themselves in the very place where phosphoric acid is most needed, in order that, as part of the food, it may build up the bones, the framework of the animal body.

These are only two of the many theoretical deductions that we have been enabled to draw during our gradual ascent.

But it is not only such theoretical and physiological questions that have been elucidated by these analyses; they indicate many facts of great importance to the practical man.

The composition of every part of the healthy plant being known, the means for obtaining a healthy crop are obvious. The inorganic part being entirely derived from the soil, to the soil must attention be directed in case of failure, and its deficiences ascertained. With these results before him, any farmer may see that if his straw refuses to stand, the chief cause is probably a lack of soluble silica in the soil. In some of the alkaline silicates now manufactured for sale, he may find a ready means of remedying the defect.

The straw, it should be noticed, does not return to the soil all that the grain has taken from it, and thus even where all the straw is returned in the shape of manure with the greatest possible care, the land may ultimately become exhausted of the materials for the inorganic part of the grain, which is all carried away and sold. With these remarks I pass on to the second division.

II.—*Of the Organic part of the Ripe Plant.*

Under this division will come more especially the nutritive properties of oats. In the consideration of the inorganic part, attention was chiefly drawn to questions connected with the circulation of the plant, and with the best means of supplying those deficiencies which are invariably found when an imperfect crop is produced.

These inorganic substances, especially the phosphates, are indispensable to our food, but they form a small part of the whole

grain, only 2 lbs. in 100. The remaining larger part merits our attentive consideration, particularly as it chiefly distinguishes the oat from other varieties of corn.

I speak here of the grain alone: that being the most important part, for its nutritive properties, I have confined my attention chiefly to it. I have also been able to make the husk the subject of a few researches. It would have been very interesting and useful to examine the straw also, but I was obliged reluctantly to conclude my observations, as the time for the delivery of this essay approached.

The proximate principles of the grain will first demand our attention, and it will be necessary, by way of preface, to give an account of the methods by which they were obtained.

The quantity of grain taken for analysis was from 75 to 100 grains.

1. This was rubbed thoroughly in a mortar, and successive portions of water added, until the starch, &c. was all washed away from the epidermis. The solution was allowed to stand in a cool place for twenty-four hours, and the liquid was then drawn off by a syphon. Fresh water was now added, and after some hours again drawn off; this was repeated until the liquid came away quite clear. The starch then remained pure, it was collected on a weighed filter, and dried at 212°, until it ceased to lose weight.

2. To the solution drawn off from the starch, acetic acid was added, to throw down the casein or avenine. This was allowed to settle, and the liquid drawn off by a syphon of small bore. The precipitate was now transferred to a weighed filter. It is necessary to stop the washing while the water is still acid, otherwise a portion of the casein will be re-dissolved. It was now dried in the same way as the starch.*

* This substance has been called casein, because in many respects it resembles some of the kinds of casein found in other bodies; but as its exact composition has not yet been determined, I use for it the provisional name of *Avenine* proposed by Professor Johnston.

From the casein of milk, it differs in some important properties. Rochleder describes the casein of milk as *soluble* in *weak acid,* but precipitated by more acid and weak alkalies. *Insoluble*, when free from acid or alkali, in *water*.

I have found the casein of oats to agree more nearly with the casein of beans, as described by Liebig. He says, " It is soluble in *cold water*, *does not* coagulate by *heating*, is precipitated by dilute acetic acid, and is *not soluble* in an *excess*."

The casein of oats is *very soluble* in pure water, being nearly all dissolved by the first water added to the bruised grain. *Weak* acetic acid causes an abundant precipitate, which an excess of acid does not seem to re-dissolve, as no precipitate fell from the liquid filtered and neutralized by carbonate of soda. Boiling a portion of the original solution did not coagulate the casein, but after cooling, on the addition of acetic acid, the precipitate fell more quickly than before. When this was filtered and neutralized by carbonate of soda, a slight precipitate fell, showing that the casein was slightly soluble in an excess of acetic acid by the aid of heat, or that there was a small quantity of albumen present.

3. The solution separated from the casein was evaporated to a very small bulk, and treated with strong alcohol to throw down the gum. After standing some hours the gum was collected on a filter, washed with alcohol, and dried as above.

From the remaining solution nothing more was determined.*

4. The epidermis, after separation from the starch as above, was collected in a retort, and boiled with acetic acid. On neutralizing the solution, a small precipitate of albumen fell. This was collected, and the epidermis boiled again in a very weak solution of caustic potash. On neutralizing the solution, another slight precipitate of some proteine compound was obtained. This was so small in quantity that it was classed with the albumen. After this boiling with caustic potash the epidermis was collected, washed, dried, and weighed.

5. To determine the oil, sugar, and glutin, a fresh portion of grain, about the same weight as before, was taken and boiled with successive portions of alcohol, until a drop left no trace on evaporation. The solution was then carefully distilled to dryness in a small retort. The dry mass was treated with successive portions of pure ether to dissolve the oil; and this ethereal solution was carefully evaporated to dryness in a small weighed capsule. After weighing, it is safer to re-dissolve the oil, and evaporate again, as some of the sugar sometimes finds its way over with it.

6. The mass left in the retort is now treated with water to dissolve the sugar; this solution is also evaporated to dryness in a small weighed capsule. It is an impure sugar, always containing more or less of the soluble salts of the inorganic part.

7. The substance originally dissolved by alcohol and finally left undissolved by water in the retort, was considered analogous to the glutin of wheat, and was accordingly set down as such in the analyses. It was collected, dried, and weighed, either in a cup or on a filter.

Having now described the process employed, I will proceed to give the results obtained by it in four specimens of grain, the same four of which the full inorganic analysis of the ash was given.

The soluble salts of the ash are in these analyses distributed to some extent among nearly all the substances. It is impossible to say how much water dissolves when the grain is unburned, and an indefinite quantity of this undetermined portion is thrown away in the solution from which the starch, &c. are obtained.

* I made some experiments upon the legumin of almonds, to which also this casein seems to bear some resemblance. A copious precipitate of legumin falls on the addition of a little acetic acid, but a small portion of it re-dissolves in an excess. From the strongly acid solution filtered and neutralised by carbonate of soda a slight precipitate falls.

The quantities contained in the precipitates can only be determined by burning them all. I have, in the following analyses, considered the greater part of the loss as alkaline salts, and have made the sums up to 100.

Proximate Composition of the Organic part, in four samples of the Grain of Oats. Calculated dry.

TABLE 36.

	Hopeton Oats, Northumbd.	Hopeton Oats, Ayrshire.	Hopeton Oats, Ayrshire.	Potato Oats, Northumbd.
Starch..............	65.24	64.80	64.79	65.60
Sugar...............	4.51	1.58	2.09	0.80
Gum................	2.10	2.41	2.12	2.28
Oil	5.44	6.97	6.41	7.38
Casein (avenine.)	15.76	16.26	17.72	16.29
Albumen...........	0.46	1.29	1.76	2.17
Glutin	2.47	1.46	1.33	1.45
Epidermis	1.18	2.39	2.84	2.28
Alkaline salts & loss.	2.84	1.84	0.94	1.75
	100.00	100.00 F	100.00 F	100.00

In reference to the above table, we naturally turn our attention

1. *To the Starch.*—The four results are remarkably uniform. I am inclined to think, however, that the starch may be stated a little too low in this table, for reasons which will afterwards appear. As the table at present stands, the quantity of starch in the oat is nearest to that in barley.

2. *The Sugar.*—This, as I have said, is impure, and a little deduction should be made from its weight, especially in Hopeton oat, No. 1.

3. *The Gum.*—The quantities of this substance are nearly alike in the four trials: wheat contains a little more—about 3 or 4 per cent.

4. *The Oil.*—The quantities of *oil* given above are large, but I think correct. The earlier analyses of oats only give from three to four-tenths of a per-cent of oil. Both Boussingault and Johnston, however, have recently found from 6 to 8 per cent. This oil is of a beautiful pale yellow colour, and its smell may be perceived on heating oatmeal cakes. The fattening qualities of the oat must be very great. The maize, or Indian corn, is celebrated for fattening animals; and Dumas gives only 9 per cent as its maximum of fatty matters. Boussingault gives 7 per cent

as the average; while Liebig has denied that it contains more than 5 per cent. If we take 7 per cent as the average, the meal of the oat, so far as the oil is concerned, should nearly equal that of the Indian corn.

5. *The Casein (avenine,) Albumen, and Glutin.*—These three I have grouped together as nitrogeneous compounds. Their quantity is certainly very remarkable, being, in the potato oat above, a little more than 20 per cent. I have been led to think, however, that the quantities of all these compounds are a little overstated in the above analyses. Every one who has engaged in this kind of organic analysis knows the exceeding difficulty of obtaining the substances perfectly pure. I am somewhat suspicious that, in defiance of my precautions, my casein precipitates may have contained a little starch. I insert the above analyses, therefore, as open to correction.

In order to arrive at a more certain result as to the actual quantity of these nitrogeneous compounds, I determined the nitrogen directly, by combustion in a number of specimens.*

The annexed table gives the result of nine of these combustions. Each burning was repeated two or three times.

TABLE 37.

Per centage.	Hopetoun Oats.			Potato Oats.		Oats from Mr Agnew, Ayrshire			Imperial oats, New York, United States.
	No 1.	No. 2.	No 3.	No. 1.	No. 2.	No. 1.	No. 2.	No. ?	
Of nitrogen.	2.19	2.35	2.28	2.76	2.82	2.89	5.51	2.49	3.00
Of protein compounds.	14.00	14.78	14.04	17.36	17.77	18.24	22.01	15.66	18.80

This table shows a range of no less than 8 per cent in the nitrogeneous compounds.

Nos. 1 and 2, from Mr Vans Agnew, were the first crop, after very old grass. No. 1 was manured with two cwt. of guano per acre harrowed in with the seed. No. 2 was *without manure.* This result is a most surprising one, and although I have repeated my trials, I feel that it needs still further confirmation. The crop

* The nitrogen was determined by combustion of the grain in a mixture of caustic soda and lime in the usual way. The method of such combustions is so well known among all chemists, and so universally inserted in all recent chemical works, that it seems quite unnecessary to enter into a lengthened description of it here. From the ammonia salt thrown down by platinum, the nitrogen is determined, and from the amount of protein compounds calculated.

being after old grass, the land must have been in good condition, and therefore would mature a crop even without the addition of guano, though that manure undoubtedly increased the yield upon the part to which it was applied. It is possible that on such a good soil with a healthy plant, the more slow growth and maturing of a less luxuriant crop than that to which guano was added, may have been more favourable to the largest possible amount of nitrogeneous compounds; so that, while the seed was less in quantity, it should be richer in quality. The opinion somewhat prevalent among farmers, that guano turnips or potatoes are less nutritious than others, seems to countenance this view.

The potato oat, No. 2, was also from a remarkably fine crop, as was the American imperial oat, which was remarkable for its weight. The three samples of Hopeton oats were all from rather inferior soils, and poor crops.

But even if we take the lowest per-centage of protein compounds, they amount to 4 per cent more than is stated to be the average quantity in wheat. The mean may, probably, be safely taken as 16 or 17 per cent.

Before concluding the organic part of the grain, I wish to give some account of the organic part of the husk, and afterwards some determinations in which the two parts are united.

I did not make a complete analysis of the proximate principles of the husk, but determined the oil and sugar only, by boiling in alcohol and ether, as described under the analysis of the grain.

The following Table gives my results in two samples of husks calculated dry:—

TABLE 38.

Per Centage.	Hopeton Oats, Hexham, Northumberland.	Potato Oats, Park-End, Northumberland.
Of oil....................	1.50	0.92
Of sugar and gum.....	0.47	0.75

Beside these substances, there was a considerable quantity of some nitrogeneous compound left undissolved by water, somewhat analogous to glutin, and amounting in one instance to 1.28 per cent. The husk, then, is by no means without value for feeding. A determination of the nitrogen by combustion, shows that, in addition to 1½ per cent of oil, it contains at least 1½ per cent more of protein compounds.

The following table gives the nitrogen in the husk and grain

separately, and afterwards in the whole oat of the same sample. The results calculated dry :—

TABLE 39.

Per Centage	Husk	Grain	Whole Oat
Of nitrogen	0 30	2 82	2 18
Of proteine compounds	1 88	17 77	13 72

A proximate analysis of Boussingault's gives 13.7, as the amount of protein compounds in the whole oat, exactly coinciding with the above determination. We see, then, that even including the husk, the oat is superior to almost any other corn, in those ingredients which go directly to the production of muscle in the body. The strong muscular forms of the Scottish ploughmen have long been living witnesses to the good properties of their favourite and almost only food; and now that it has been shown what those properties really are, I feel sure that Dr Johnson's definition of oats—"Food for men in Scotland, and for horses in England"—will be remembered only for its appropriate answer—"And where will you find such men and such horses?"

In conclusion, I may be permitted to say, that the extent of this investigation, and the many points which I have been compelled to leave undetermined, or doubtful, after eighteen months of constant labour, must convince those who entertain false ideas of the time and patience necessary for chemical researches of this kind, that they have erred in supposing the chemist able to do in a few days or weeks, what can only be effected by the labour and study of many successive years.

In presenting my results to the Society, it is with a consciousness of their imperfections, and a feeling that it would have been most desirable to extend them much further in every direction.

At the same time, I think that much *new* ground has been gone over, and that in many respects the bounds of our knowledge, with regard to the oat plant, have been considerably enlarged.

I have endeavoured to condense rather than extend my conclusions and descriptions, which might have reached a very great length indeed, from the mass of tables and facts now presented.

LABORATORY OF THE AGRICULTURAL CHEMISTRY ASSOCIATION,
October 1845.

REPORT OF EXPERIMENTS SHOWING THE CONTINUED EFFECTS OF THE APPLICATION OF SPECIAL MANURES.

By Mr A. F. Gardner, Overseer to W. M. Fleming, Esq. of Barrochan, Renfrewshire.

[Premium, Fifteen Sovereigns.]

In laying before the Society, for their consideration, the following report of the continued effects of special manures, it has been the endeavour of the reporter to make them as clear as possible. The results from the crops grown from each description of manure, for each of the years to which the experiments extend, have been put upon a table by themselves, so that the effects of the manures or mixtures applied to each crop of the rotation may be seen and compared at once.

The conclusions drawn from the tables of experiments, and subsequent results, might have been much extended from numerous notes, taken for years, during which many extensive experiments were made; but it has not been in the reporter's power to accomplish this in sufficient time given by the Society for the lodging of such a report this season.

Remarks upon Tables Nos. I. and II.

1842.—The soil upon which these crops were grown is a stiff loam, lying upon a clay sub-soil of great depth, superincumbent upon sandstone rock: it is thoroughly drained with tiles and soles; the drains thirty inches deep and twelve feet apart. It was trenched out of lea, with the spade, in the winter of 1841 and 1842, sixteen inches deep; the subsoil was brought up from that depth, and put upon the surface, and the grass side or top spading put into the bottom of the trench. The land was prepared in the usual manner, and drilled thirty inches apart; the farm-yard manure was spread evenly in the bottom of the drills, after which cut sets of the seed potatoes were laid upon the top of the dung, and covered with the plough about three inches deep. The potato plants came all through the ground regularly, and when they were about six inches high, which was about the 4th July, the special manures, mentioned in the tables, were sown upon the tops of the drills during the time of heavy rain. In the course of a week after their application they produced their usual effects, viz., dark green colour and luxuriant growth, and which

they all continued to exhibit except No. 4, (soot,) till the plants were cut down by frost. The tops began to ripen upon the portion dressed with soot (No. 4,) about a fortnight before the others. Crop lifted and weighed in the beginning of October 1842.

1843.—The ground was ploughed in the spring of 1840, and sown with potato oats in the beginning of April, the divisions of the different portions upon which the top-dressing for the potato crop was put being still kept distinct. The oats were remarkable for strength and vigour upon the portions Nos. 2 and 3, and continued so all season, and were later of ripening than the other two portions. No. 4 was first ripe, and considerably shorter in the straw than the other three portions. No. 1 was a fair average crop. The after effects these top-dressings had upon this crop presented a very remarkable appearance during the course of the season; the oats upon portions Nos. 2 and 3, being considerably higher and stronger than upon the other two portions, had the appearance of being dove-tailed, as it were, by the ploughing into the weaker portions.

1844.—The oat crop was sown down with rye-grass, clover, and natural-grass seeds in 1843. The crop of hay on these portions presented no difference in appearance in 1844; all the influence these top-dressings had upon the two former crops in promoting their growth, seemed to have been exhausted; however, the sward of grass, as sheep pasture, is close bottomed, vigorous, and healthy.

From the above experiments, it appears that on this land sulphate of ammonia and sulphate of soda, mixed and applied to the green crop, will have an influence upon it for two years, and that the nitrate and sulphate of soda produce larger and more profitable crops.

Remarks upon Tables Nos. III. and IV.

1842.—The soil upon which the crops in 1842, 1843, and 1844, were grown, is an alluvial loam, of from three to four feet deep, quite level, and is exposed on all sides. It is thoroughly drained with tiles, and is perfectly dry. The portions selected for these experiments is of uniform quality, in the centre of about fifteen acres of land which was under a turnip crop. The land was prepared and drilled in the usual manner. The burnt bones, (No. 3,) were drilled in with the seed. No. 4, (sulphate of soda,) was put on as a top-dressing during the time of rain, about the middle of June. No. 1, (moss and guano;) in applying these, the drills were formed as usual, when the moss was spread in the bottom, and the guano sowed as near as possible, broad cast, upon

the top of the moss, after which the moss and guano were covered in with the plough, and the seed drilled in upon the top of the drills; this experiment extended over one imperial acre. All the portions brairded well and evenly; No. 4 had the strongest tops of any. No. 1, moss and guano, produced the largest crop of any, with large dark green tops, and very fine bulbs. Crop lifted and weighed in December.

1843.—The above divisions being kept up, the land was ploughed in spring, and sown with potato oats, which brairded well and evenly. No. 4, moss and guano, took the lead of all the others, and the straw was about from ten to twelve inches higher than upon any other part of the field. The oats upon No. 3 (burnt bones,) were remarkable for their weight per bushel, being 45 lbs.; 2 lbs. per bushel more than on any other part of the field, the crop being very fine all over. The field was sown down with a mixture of rye-grass, clover, and natural grasses, for permanent pasture.

1844.—It was this season cut for hay, the divisions made for the different manures in 1842 being kept distinct. The hay upon each portion was saved and weighed separately. Owing to the long-continued drought, the hay was, in general, light and deficient in bulk; and this field having been also pastured in the spring months with sheep and lambs, till April, the crop was not so heavy as might have been expected.

The conclusions to be drawn from these crops, for three years, are—1st, That moss and guano are able to supply the place of farm-yard manure in a greater degree than any other substance that has yet been tried here; and from the experience of the last four years it has been found that a mixture of dung and guano, in the proportion of from ten to fourteen tons of the former to three to five cwt. of the latter, will raise a larger crop, in the first instance, than from thirty to forty tons of dung alone, and leave the land in as good, if not better condition for the after crops, at about one-half the expense of the dung. 2d, That burnt bones are equal, if not superior, to fresh bones, for raising crops to which bones are applicable as a manure; and that bones will, (if applied to green crops on land in which their constituents are deficient,) keep up the fertility of such land in a high degree for the after crops. Bone-dust was applied nine years ago as manure for a turnip crop, in a field of medium soil, and this field was trenched this season and sown with oats. The land where the bones had been put gave seven bushels oats, and fifty stones more straw than that land to which farm-yard manure had been applied at the same time to the turnip crop, besides the grain having been 2 lbs. per bushel heavier; and, during the time this field lay in grass, the portion manured with the bones could be pointed out

from the rest by a darker colour and greater luxuriance of pasture. 3d, That sulphate of soda, applied to green crops, does not seem to have any influence upon crops after the second year of its application.

Remarks upon Tables Nos. V. and VI.

1842.—The soil upon which these three years' crops were grown, is a stiff loam of great depth, lying level, was thoroughly drained with tiles, and is quite dry. It is cropped upon a four-course rotation, viz.: first year, oats from hay stubble; second year, green crop, potatoes or turnips; third year, wheat or barley, sown down with rye-grass, clover, and timothy-grass; and, fourth year, hay, &c. The field was fallowed in the winter of 1841 and 1842; and at the end of May and beginning of June was worked and drilled in the usual manner with plough and harrow. There were a few days of difference in the sowing of the seed upon the different manures, owing to the ground being sown as it was prepared; not exceeding, however, ten days between the first and last sowings. All the manures in the tables gave a fair crop of turnips, considering the great difficulty in preparing such land, and putting it in proper tilth to receive the seed. The experiments were made upon a large scale, about two acres being allotted to each kind of manure.

1843.—After the turnip crop was lifted, the land was ploughed and sown in spring with Annat barley, rye-grass, and clover seeds. There was no apparent difference in the barley upon the various manurings during the course of the season; all having the appearance of a fair average crop.

1844.—The hay crop this season was very good, considering the dryness of the weather. After being cut, a most luxuriant crop of clover aftermath came up, giving, upon an average, about nine tons per acre when cut green.

The general result of these experiments shows that artificial manures of the same description will give, on this land, a good average crop of turnips, and at much less expense than farm-yard manure, while, at the same time, the succeeding crops of the rotation are as good, in general, and in some cases better.

Remarks upon Tables Nos. VII. and VIII.

1843.—The field upon which these crops for two years had been grown, is a light gravelly loam; subsoil deep gravelly till. There was a crop of oats taken from it, after old lea, in 1842.

During the winter of 1842 and 1843, it was ploughed and subsoiled with a common plough, from which the mould-board was taken, and prepared and drilled in the usual manner in spring, for a potato crop, to which crop these manures and mixtures were applied. The potato seed was cut into sets, and laid upon the top of the farm-yard manure, and covered, with the plough, three inches deep. Each of the specific manures, applied when the plants were six inches high, had the effect of increasing the crop, and particularly the mixtures of nitrate and sulphate of soda, and of the sulphates of ammonia and soda as top-dressings, and the addition of guano to half the usual quantity of dung, all of which produced great increase over the others at a small expense. No. 2., (soot) also added considerably to the potato crop, but its effects on it are quickly exhausted on this land; for, wherever soot has been applied, the potatoes have invariably ripened earlier than any other portion of the field. The portion, No. 5—manured, in addition to the farm-yard manure, with bones dissolved in sulphuric acid, and carbonate of magnesia stirred into it till the solution was dried up—increased the growth of the stems and leaves, but without altering the colour. The tubers from this portion were particularly large and fine. Particular attention is required, in the application of guano to crops, that it be regularly spread in the drills, for if it comes in contact with the young shoots, it tends to burn them, and sometimes to kill them altogether.

1844.—All these dressings, except soot, have continued their effect upon the oat crop of this season, and have added considerably to the produce, both of straw and grain; and the effect was visible all season, from the time the oats brairded till they were cut, and particularly in Nos. 3 and 4, which were remarkable for their height and luxuriance over all the rest of the field. No. 4 was also remarkable for its continued effect of producing a dark green colour, even in the second year after its application, as it always does to most crops to which it is applied the first season. No. 5 was very noticeable from being also strong and vigorous all season, and presenting the remarkable appearance of a standing crop, while most of the others surrounding it were laid sometimes before ripening, and made the oats 2 lbs. per bushel heavier than the others. No. 4., (soot) dressed upon the potato crop, gave this season the worst crop of oats in the whole field, which was completely marked out from the rest, by the crops being thinner upon the land and shorter in the straw. It seems not only to have exhausted itself in the potato crop, but to have hastened, at the same time, the exhaustion of the farm-yard manure. This invariably follows the application of soot by itself, upon this land, upon whatever crop it may be used; but when mixed

with common salt and animal charcoal, its effects are more lasting, and can be noticed during the rotation both of grain and green crops. I would particularly direct the attention of the Society to No. 6; not only from this manure costing less at first, by nearly a half, but now, from four years' experience, I can say that, upon this land, it gives a larger crop of potatoes and turnips than thirty tons of farm-yard manure; and that its good effects are continued in the grain crop which follows, as also in the hay and pasture. The sown grasses and clover in this field, upon the ground so manured, are very fine, being close bottomed and luxuriant, and there was an extra crop of clover upon it beyond the others.

Remarks upon Tables Nos. IX. and X.

The same remarks,—as regards soil, exposure, drainage, &c., apply to these tables, as to Tables Nos. VII. and VIII. The crops were grown upon part of the same field; and, in like manner, any remarks on the different appearances of the turnip and oat crops being nearly the same, a repetition is here considered unnecessary. The compost, No. 6, was made as follows:—40 bushels of saw-dust, or moss, to 20 gallons of coal tar; 7 bushels of bone-dust, 1 cwt. of sulphate of soda, 1½ cwt. of sulphate of magnesia, and 1½ cwt. of common salt, mixed and fermented for some days before being used.

Remarks on Table No. XI.

The field upon which these crops were grown, is a soil of medium texture, lying upon trap-rock. In the winter of 1842 and 1843, it was trenched with the spade, from seven years' old lea, to the depth of sixteen inches, and the subsoil brought to the top. The drills were formed for the potato crop of 1843, with a double mould-board plough, and the special manures sown with the hand, as neatly as possible broad-cast in the drills; after which the farm-yard manure was spread upon the top of them, and cut sets of the seed potatoes laid upon the top of the manure, and covered up. The plants were all seen in rows by the 7th June, and the land worked with drill grubbers, &c. The crop all over the field, about five acres, was remarkable the whole season for its strength and vigour, and particularly on Nos. 2 and 3, both of which gave a very heavy crop, and would have been still greater had the drills been made wider than usual, and the sets been planted wider apart.

1844.—It was ploughed again and sown with barley, (common white) and, at the same time, with a mixture of grasses and

clover for permanent pasture. The barley was sown in the end of April, and notwithstanding the severe drought which prevailed this season, it brairded quickly and evenly. It continued to grow most luxuriantly, so much so, that by the time the plants came into bloom, the crops was laid so flat, that, had it been a wet season, it would have been worth nothing but for the dung-heap. Owing, however, to the favourableness of the season it produced a very heavy crop of straw and grain, the grain averaging 55 lbs. per bushel.

This table of results further tends to show, if it be still required, the efficacy of guano, to supply the want of farm-yard manure, and also to give the cultivator of such soils as this the assurance, that by its application to his lands, he will increase his crops at less expense than by the use of farm-yard dung alone. The sown grasses now, in Nov. 1844, are more luxuriant, and of a darker green colour upon Nos. 2 and 3, than upon No. 1.

I may here mention the effect of guano in growing a crop of cabbages this season. The soil upon which they were grown is about two acres of improved moss land, trenched with the spade in 1842, and the subsoil brought to the surface. It was cropped with potatoes in 1843, manured with twelve tons farm-yard manure and three cwts. guano per acre, and produced a crop of upwards of fifteen tons per acre. It was again dug this spring with the trenching-grape, when two cwt. of guano per acre was sown by the hand, broadcast, and harrowed in. After which, in the beginning of April, the cabbages (Drumhead) were dibbled in upon about an acre, and the other portion sown with mangelwurzel, the land being cleaned and worked in the usual manner. These crops have grown most luxuriantly, the cabbages giving a crop of upwards of sixty tons per acre, most of them averaging from 20 to 40 lbs. a-piece. The mangelwurzel is now, (Nov.) still growing, but has been estimated by good judges to be forty tons and upwards per acre of clean roots, many of them averaging 10 to 12 lbs. a-piece.

I may here remark, that upon every description of crop and land upon this farm, special manures are applied with the greatest success, greatly adding to the productiveness of the soil. On being judiciously applied according to the various wants of the crops, they have largely added to our green crops, increased our grain crops, and augmented their weight per bushel, while their application to our pasture-lands has benefited them in a very high degree.

No. I.

Results of Three Years' Crops on land Manured with Guano and other Special Manures, in the Years 1842, 1843, *and* 1844.

Potatoes valued at 40s. per ton; Oats, at 2s. 6d. per bushel; Hay at £3 per ton; and Straw 2s. per cwt.

	Application of manures to green crop for the rotation.	Quantity of farm-yard manure applied per acre.	Quantity of special manure applied per acre	Cost of manure per acre, 1842.	Amount of produce. Potatoes per acre, 1842.	Oats per acre, 1843.	Straw per acre, 1843.	Hay per acre, 1844.	Value of the crops per acre for three years.	REMARKS.
		Tons cwts.	Cwts. lbs.	L. s. d.	Tns. cwts. lbs.	Qrs. bushels.	Cwts. lbs.	Tons cwts.	L. s. d.	
	No. 1.									
1842	Farmyard manure.	25 0	... ...	8 15 0	9 3 90	... ...	... ...	... ...	18 7 6	1842.—Trenching lea, £3, 6s. 8d; seed potatoes, 15 cwt., 10s.; planting, hoeing, &c., £2; lifting and pitting, £1, 5s; manure, £8, 15s. Total, £16, 16s. 8d. 1843.—Ploughing, harrowing, &c., £1; five bushels seed oats, 15s.; cutting, stacking, thrashing, cleaning, &c., £1. Total, £2, 15s. 1844.—Cutting, 2s. 6d.; winnowing, stacking, &c., 7s. Total, 9s. 6d. Total expense, £20, 1s. 2d.; total value, £37, 0s. 9d.; leaving £16, 19s. 7d. for rent and per centage on capital.
1843	... ...	... ...	... ...	... ...	... ...	8 1 0	36 17	... ...	11 12 3	
1844	... ...	... ...	... ...	... ...	... ...	... ...	... ...	2 7	7 1 0	
				8 15 0					37 0 9	
	No. 2.									
1842	Farm-yard manure	25 0	... ...	8 15 0	... ...	... ...	... ...	... ...	... ...	1842.—Outlay: trenching lea, £3, 6s. 8d.; manure, £9, 12s.; seed-potatoes, 15 cwt., £1, 10s.; planting, hoeing, &c., £2; lifting, pitting, &c., £1, 5s. Total expense, £17, 13s. 8d. per acre. 1843.—Ploughing, harrowing, &c., £1; 5 bushels seed-oats, 15s.; cutting, stacking, thrashing, cleaning, &c., £1. Total, £2, 15s. 1844.—Cutting, 2s. 6d.; winnowing, stacking, &c., 7s. Total 9s. 6d. Total expense in three years, £20, 18s. 2d.; total value of the three years' crop, £50, 4s.; leaving £29, 5s. 10d. for rent and percentage on capital.
1842	Nitrate of soda......	... ...	0 56	0 10 0	15 1 16	... ...	... ...	... ...	30 2 3	
1842	Sulphate of soda....	... ..	1 0	0 7 0	... ...	... ...	... ...	... ...	... ...	
1843	Continued effects of above.........	... ...	... ...	... ...	... ...	8 5 0	47 23	... ...	13 6 9	
1844	... ...	... ...	... ...	... ...	... ...	... ...	... ...	2 5	6 15 0	
				9 12 0					50 4 0	

No. II.

Results of Three Years' Crops on land Manured with Guano and other Special Manures, in 1842, 1843, and 1844.

Potatoes valued at 40s. per ton; Oats at 2s. 6d. per bushel; Hay at £3 per ton; and Straw at 2s. per cwt.

	Application of manures to green crop for the rotation.	Quantity of farm-yard manure applied per acre.	Quantity of special manure applied per acre.	Cost of manures per acre, 1842.	Amount of produce. Potatoes per acre, 1842.	Amount of produce. Oats per acre, 1843.	Amount of produce. Straw per acre, 1843.	Amount of produce. Hay per acre, 1844.	Value of the crops per acre for three years.	REMARKS.
		Tons cwts.	Cwts. lbs.	L. s. d.	Tns. cwts. lbs.	Qrs. bu. pks.	Cwts. lbs.	Tons cwts.	L. s. d.	
	No. 3.									
1842	Farm-yard manure	25 0	... ...	8 15 0	13 6 18	... ...	... ...	... ...	26 12 3	1842.—Trenching of lea, £3, 6s. 8d.; manure, £9, 12s.; seed-potatoes, 15 cwt., £1, 10s.; planting, hoeing, &c., £2; lifting, pitting, &c., £1, 5s. Total expense, £17, 13s. 8d.
	Sulph. of Ammonia	... ...	0 56	0 10 0						1843.—Ploughing, harrowing, &c., £1; 5 bushels seed-oats, 15s.; cutting, stacking, thrashing, and cleaning oats, &c., £1. Total, £2, 15s.
	Sulphate of Soda...	... ...	1 0	0 7 0						1844.—Cutting hay, 2s. 6d.; winning, stacking, &c., 7s. Total, 9s. 6d. Total expense, £20, 18s. 2d. Total value, £45, 15s. 7½d.; leaving for rent, &c., £24, 17s. 5½d.
1843	Continued effects of the above....	... ...	... ...	... ...	... ...	8 3 3	41 69	... ...	12 11 4½	
1844	... ...	... ...	... ...	... ...	... ...	... ...	... ...	2 4	6 12 0	
				9 12 0					45 15 7½	
	No. 4.									
1842	Farm-yard manure	25 0	... ...	8 15 0	10 2 28	... ...	... ...	... ...	20 4 6	1842.—Trenching lea, £3, 6s. 8d.; seed-potatoes, 15 cwt., £1, 10s.; planting, hoeing, &c., £2; lifting and pitting, £1, 5s.; manure, £9, 5s. Total, £17, 6s. 8d.
	Soot....................	... ...	bu. 40 0	0 10 0						1843.—Ploughing and harrowing in seed-oats, £1; 5 bushels seed oats, 15s.; cutting, stacking, and barn-work, £1. Total, £2, 15s.
1843	Continued effects of the above....	... ...	... ...	... ...	... ...	7 5 2	33 98	... ...	11 0 0	1844.—Cutting, 2s. 6d.; winning, stacking, &c., 7s.; total, 9s. 6d. Total three years' expense, £20, 11s. 2d.; total value, three years' crops, £36, 18s. 6d.; leaving for rent, &c., £16, 7s. 4d.
1844	... ...	... ...	... ...	... ...	... ...	... ...	... ...	1 18	5 14 0	
				9 5 0					36 18 6	

No. III.

Results of Three Years' Crops on land Manured with Guano and other Special Manures, in 1842, 1843, *and* 1844.

Turnips valued at 15s. per ton; Oats at 2s. 6d. per bushel; Hay at £3 per ton; Straw, 7s. per cwt.

	Application of manures to green crop for the rotation.	Quantity of farm-yard manure applied per acre, 1842.	Quantity of special manures applied per acre, 1842.	Cost of manures per acre, 1842.	Amount of produce. Turnips per acre, 1842.	Oats per acre, 1843.	Straw per acre, 1843.	Hay per acre, 1844.	Value of the crops per acre for three years.	REMARKS.
		Tons. cwts.	Cwts. lbs.	L. s. d.	Tns. cwts. lbs.	Qrs. bu. pks.	Cwts. lbs.	Tons cwts.	L. s. d.	
	No. 1.									
1842	Moss.....................	15 0	... ...	0 15 0	26 0 20	... ...	... ...	... ...	19 10 0	1842.—Ploughing stubble, 15s.; cross-ploughing, harrowing, and drilling, £2; Turnip-seed, 4s.; hoeing, thinning, topping, and tailing, 8s.; driving home, 10s.; manure, £2, 8s. Total, £6, 5s.
1842	Guano....................	... ...	3 0	1 13 0						
1843	Continued effects...	... ...	... ...	... ...	... ...	8 1 3	49 31	... ...	13 2 10½	1843.—Ploughing and harrowing in seed-oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, thrashing, and cleaning, &c., £1. Total, £2, 12s.
1844	... ...	... ...	... ...	... ...	... ...	... ...	... ...	2 10	7 10 0	1844.—Cutting, 2s. 6d.; winning, stacking, &c., 7s. Total, 9s. 6d. Total expense for three years, £9, 6s. 6d.; total value, £40, 2s. 10½d.; leaving £30, 16s. 4½d. for rent and per-centage on capital.
				2 8 0					40 2 10½	
	No. 2.									
1842	Farm-yard dung....	25 0	... ...	8 15 0	17 3 0	... ...	... ...	... ...	12 17 5	1842.—Ploughing oat stubble, 15s.; cross ploughing, and harrowing and drilling, £2; turnip-seed, 4s.; hoeing and thinning, 10s.; topping and tailing, 8s.; carting home, 10s; manure, £8, 15s. Total expense, £13, 2s
1843	Continued effects...	... ...	... ...	... ...	... ...	7 4 2	43 59	... ...	11 18 3	1843.—Ploughing and harrowing in seed-oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, thrashing, and cleaning, &c., £1. Total, £2, 12s.
1844	... ...	... ...	... ...	... ...	... ...	... ...	... ...	2 1½	6 4 6	1844.—Cutting, 2s. 6d; winning, stacking, &c., 7s. Total expense, 9s. 6d. Total expense for three years, £16, 3s. 6d.; total value, £31, 0s. 2d.; leaving £14, 16s. 8d for rent and per-centage on capital.
				8 15 0					31 0 2	

No. IV.

Results of Three Years' Crops on land Manured with Guano and other Special Manures, in 1842, 1843, and 1844.

Turnips valued at 15s. per ton; Oats at 2s. 6d. per bushel; Straw at 2s. per cwt.; and Hay at £3 per ton.

	Application of manures to green crop for the rotation.	Quantity of farm-yard manure applied per acre.	Quantity of special manure applied per acre.	Cost of manures per acre, 1842.	Amount of produce. Turnips per acre, 1842.	Amount of produce. Oats per acre, 1843.	Amount of produce. Straw per acre, 1843.	Amount of produce. Hay per acre, 1844.	Value of the crops per acre for three years.	REMARKS.
		Tons cwts.	Cwts. lbs.	L. s. d.	Tns. cwts. lbs.	Qrs. bu. pks.	Cwts. lbs.	Tons cwts.	L. s. d.	
	No. 3.									
1842	Farm-yard dung....	25 0	... ...	8 15 0	23 5 28	... ...	... ...	... ...	17 8 9	1842. Ploughing oats and stubble, 15s.; cross-ploughing, harrowing, and drilling, £2; turnip-seed, 1s.; hoeing and thinning, 10s.; topping and tailing, 8s.; carting home, 10s.; manure, £10, 8s. Total, £14, 15s.
	Burnt bones.........	... ...	1 56	1 13 0						
1843	Continued effects...	... ...	... ...	... ...	... ...	7 7 0	43 106	... ...	12 5 0	1843.—Ploughing and harrowing in seed-oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, thrashing, cleaning, &c., £1. Total, £2, 12s.
1844	... ...	... ...	... ...	... ...	... ...	... ...	... ...	2 5½	6 16 6	1844.—Cutting, 2s. 6d.; winning, stacking, &c., 7s.; total, 9s. 6d. Total expense for three years, £17, 16s. 6d. Total value, £36, 10s. 3d.; leaving £18, 13s. 9d. for rent and per-centage on capital.
				10 8 0					36 10 3	
	No. 4.									
1842	Farm-yard manure	25 0	... ...	8 15 0	20 1 0	... ...	... ...	... ...	15 7 0	1842.—Ploughing stubble, 15s.; cross-ploughing, harrowing, and drilling, £2; turnip-seed, 4s.; hoeing and thinning, 10s.; topping and tailing, 8s.; carting home, 10s. Total, with manure, £14, 3s.
	Sulphate of Soda....	... ...	3 0	1 1 0						
1843	Continued effects...	... ...	... ...	... ...	... ...	7 2 1	39 35	... ...	10 14 1½	1843.—Ploughing and harrowing in seed-oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, thrashing, and cleaning, &c., £1. Total, £2, 12s.
1844	... ...	... ...	... ...	... ...	... ...	... ...	... ...	2 0	6 0 0	1844.—Cutting, 2s. 6d.; winning, stacking, &c., 7s. Total, 9s. 6d. Total expense for three years, £17, 4s. 6d.; total value, £32, 1s. 1½d.; leaving £14, 16s. 7½d. for rent and per-centage on capital.
				9 16 0					32 1 1½	

No. V.

Results of Three Years' Crops on land Manured with Guano and other Special Manures, in 1842, 1843, *and* 1844.

Turnips valued at 15s. per ton; Barley at 3s. 4d. per bushel; Straw at 1s. 6d. per cwt.; Hay, £3 per ton.

	Application of manures to green crop for the rotation.	Quantity of farm-yard manure applied per acre. Tons cwts	Quantity of special manure applied per acre. Cwts. lbs.	Cost of manures per acre, 1842. L. s. d.	Amount of produce. Turnips per acre, 1842. Tns. cwts. lbs.	Barley per acre, 1843. Qrs. bu. pks.	Straw, per acre, 1843. Cwts. lbs.	Hay per acre, 1844. Tons cwts.	Value of the crops per acre for three years. L. s. d.	REMARKS.
	No. 1.									
1842	Town dung &c.……	30 0	… …	9 0 0	24 0 0					1842. Ploughing oat stubble, 15s.; cross-ploughing, harrowing, and drilling, £2; turnip-seed, 4s.; hoeing and thinning, 10s.; topping and tailing, 8s.; driving 10s.; manure, £10, 15s. Total, £15, 2s.
	Bone-dust …………	… …	bu. 14 0	1 15 0		… … …	… …	… …	18 0 0	
1843	Continued effects…	… …	… …	… …	… … …	6 2 0	35 80	… …	10 19 11	1843. Ploughing and harrowing in seed-barley, £1; 4 bushels seed-barley, 15s.; cutting, stacking, thrashing, and cleaning, £1, 3s. Total, £2, 18s.
1844	… … …	… …	… …	… …	… … …	… … …	… …	2 7½	7 8 6	1844.—Cutting, 2s. 6d.; winning and stacking, 7s.; cutting clover aftermath, 2s. 6d. Total, 12s.
	… … …	… …	… …	… …	… … …	… … …	… …	9* 0	4 10 0	Total expenses for three years, £18, 12s.; total value, £40, 18s. 5d.; leaving £22, 6s. 5d. for rent and per-centage on capital.
				10 15 0					40 18 5	
	No. 2.									
1842	Farm-yard dung…	25 0	… …	8 15 0	19 0 0					1842.—Ploughing of oat stubble, 15s.; cross-ploughing, harrowing, and drilling, £2; turnip-seed, 4s.; hoeing and thinning, 10s.; topping and tailing, 8s.; driving 10s; manure, £10. Total, £14, 7s.
	Bone-dust…………	… …	bu. 10 0	1 5 0		… … …	… …	… …	14 5 0	
1843	Continued effects…	… …	… …	… …	… … …	6 0 0	33 0	… …	10 9 6	1843.—Ploughing and harrowing in seed-barley, £1; 4 bushels seed-barley, 15s.; cutting, stacking, thrashing, and cleaning, £1, 3s. Total, £2, 18s.
1844	… … …	… …	… …	… …	… … …	… … …	… …	2 2	6 6 0	1844.—Cutting, 2s. 6d.; winning and stacking, 7s.; cutting aftermath of clover, 2s. 6d. Total, 12s.
	… … …	… …	… …	… …	… … …	… … …	… …	9* 0	4 10 0	Total outlay for three years, £17, 17s.; total value, £35, 10s. 6d; leaving for rent and per-centage on capital, £17, 13s. 6d.
				10 0 0				* Aftermath of clover.	35 10 6	

No. VI.

Results of Three Years' Crops on land Manured with Guano and other Special Manures, in 1842, 1843, *and* 1844.

Turnips valued at 15s. per ton; Barley at 3s. 4d. per bushel; Straw at 1s. 6d. per cwt.; and Hay at £3 per ton.

	Application of manures to the green crop for the rotation.	Quantity of farm-yard manure applied per acre.		Quantity of special manure applied per acre.		Cost of manures per acre, 1842.	Amount of produce. Turnips per acre, 1842.	Barley per acre, 1843.	Straw per acre, 1843.		Hay per acre, 1844.		Value of the crops per acre for three years.	REMARKS.
	No. 3.	Tons	cwts.	Cwts.	lbs	L. s. d.	Tns. cwts. lbs.	Qrs. bu. pks.	Cwts.	lbs.	Tons	cwts.	L. s. d.	
1842	Artificial Guano....	..	...	2	0	0 10 0								1842 Ploughing oat stubble, 15s.; cross-ploughing, harrowing, and drilling, £2; turnip-seed, 4s.; hoeing and thinning, 10s.; topping and tailing, 8s.; driving, 10s.; man. £3, 2s. 6d. Total, £7, 9s. 6d
	Humus	...	...	bu. 40	0	2 0 0	20 0 0	.. ..	...	...	...	...	15 5 0	
	Peat ashes..........	...	...	5	0	0 12 6								
1843	Continued effects...	...	...	...	...	... ...	... ...	6 4 0	35	0	...	...	11 5 10	1843. Ploughing and harrowing in seed-barley, £1; 4 bushels seed-barley, 15s.; cutting, stacking, thrashing, and cleaning, £1, 3s. Total, £2, 18s.
1844	... ...	...	...	...	...	... ...	... ...	... ...	...	...	2	5	6 15 0	1844. Cutting, 2s. 6d.; weighing and stacking, 7s.; cutting clover after math, 2s. 6d. Total 12s.
	... ...	...	...	...	...	... ...	... ...	... ...	...	...	9*	0	4 10 0	Total expenses for three years, £10, 19s. 6d.; total value, £37, 15s. 10d.; leaving £26, 16s. 4d. for rent and per-centage on capital.
						3 2 6							37 15 10	
	No. 4.													
1842	Peruvian Guano....	...	...	1	0	0 11 0	18 0 0	... ...	...	...	...	...	13 10 0	1842.—Ploughing oat stubble, 15s.; cross-ploughing, harrowing, and drilling, £2; turnip-seed, 4s.; hoeing and thinning, 10s.; topping and tailing, 8s.; driving, 10s.; manure, £2, 11s. Total, £6, 18s.
	Humus..............	..	...	bu. 40	0	2 0 0								
1843	Continued effects...	...	...	...	...	... ...	... ...	5 5 0	28	95	...	...	9 13 0	1843.—Ploughing and harrowing in seed-barley, £1; 4 bushels seed-barley, £15s.; cutting, stacking, thrashing, and cleaning, £1, 3s. Total, £2, 18s.
1844	... ...	...	...	...	...	... ...	... ...	... ...	...	...	1	17	5 11 0	
	... ...	...	...	...	...	... ...	... ...	... ...	...	...	7*	0	3 10 0	1844.—Cutting, 2s. 6d.; weighing and stacking, 7s.; cutting clover aftermath, 2s. 6d. Total, 12s.
						2 11 0					* Aftermath of clover.		32 4 0	Total expense for three years, £10, 8s.; total value, £32, 4s.; leaving for rent and per-centage on capital, £21, 16s.

No. VII.

Results of Two Years' Crops on land Manured with Guano and other Special Manures, in 1843 *and* 1844.

Potatoes valued at 40s. per ton; Oats at 2s. 6d. per bushel; Straw at 2s. per cwt.

	Applications of manures to the green crop for the rotation.	Quantity of farm-yard manure applied per acre.		Quantity of special manure applied per acre.		Cost of manure per acre, 1843.	Amount of produce. Potatoes per acre, 1843.	Oats per acre, 1844.	Straw per acre, 1844.		Value of the crops per acre for two years.	REMARKS.
	No. 1.	Tons	cwts.	Cwts.	lbs.	L. s. d.	Tns. cwts. lbs.	Qrs. bu. pks.	Cwts.	lbs.	L. s. d.	
1843	Farm-yard manure	28	0	...	...	9 18 0	11 16 32	... ...	...	...	23 12 7	1843. Ploughing oat stubble, £1, 10s.; cross-ploughing, harrowing, and drilling, £2; seed-potatoes, 15 cwt., £1, 10s.; hoeing and working, £1; lifting and pitting, £1, 5s.; manure, £9, 18s. Total expense, £17, 3s.
1844	Continued effects...	...	...	...	...	... ...	... ...	7 4 2	40	93	11 12 9	1844 Ploughing and harrowing in seed oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, and barn-work, £1. Total, £2, 12s. Total expense of two years, £19, 15s.; total value of two years' produce, £35, 5s. 4d.; leaving £15, 10s. 4d. for rent and per-centage on capital.
						9 18 0					35 5 4	
	No. 2.											
1843	Farm-yard manure	28	0	...	...	9 18 0	13 4 32	... ...	...	...	26 8 5	1843.—Ploughing oat stubble, £1, 10s.; cross-ploughing, harrowing, and drilling, £2, seed potatoes, 15 cwt., £1, 10s.; hoeing and working, £1; lifting and pitting, £1, 5s.; manure, £10, 10s. Total expense, £17, 15s.
	Soot	...	...	bu. 48	0	0 12 0						
1844	Continued effects...	...	...	...	...	... ...	... ...	7 2 1	39	47	11 11 1½	1844 Ploughing and harrowing in seed oats, £1; 4 bushels seed oats, 12s.; cutting, stacking, and barn-work, £1. Total, £2, 12s. Total value for two years, £38, 2s. 6½d.; total outlay, £20, 7s.; leaving for rent and per-centage on capital, £17, 15s. 6½d.
						10 10 0					38 2 6½	
	No. 3.											
1843	Farm-yard manure	28	0	...	...	9 18 0	14 12 96	... ...	...	...	29 5 8	1843.—Ploughing oat stubble, £1, 10s.; cross-ploughing, harrowing, and drilling, £2; seed-potatoes, 15 cwt., £1, 10s.; hoeing and working, £1; lifting and pitting, £1, 5s.; manure, £11, 5s. Total expense, £18, 10s.
	Nitrate of Soda......	...	...	1	0	0 18 0						
	Sulphate of Soda...	...	...	1	56	0 9 0						
1844	Continued effects...	...	...	...	...	... ...	... ...	8 7 2	45	0	13 8 2½	1844 – Ploughing and harrowing in seed oats, £1; 4 bushels seed-oats, 12s.; cutting and barn-work, £1. Total, £2, 12s. Total expense for two years, £21, 2s.; total value, £42, 13s. 10½d.; leaving for per-centage on capital and rent, £21, 11s. 10½d.
						11 5 0					42 13 10½	

No. VIII.

Results of Two Years' Crops on land Manured with Guano and other Special Manures, in 1843 *and* 1844.

Potatoes valued at 40s. per ton; Oats at 2s. 6d. per bushel; Straw at 2s. per cwt.

Year	Application of manures to the green crop for the rotation.	Quantity of Farm-yard manure applied per acre. Tons cwts.	Quantity of special manure applied per acre. Cwts. lbs.	Cost of manure per acre, 1843. L. s. d.	Amount of produce. Turnips per acre, 1843. Tns. cwts. lbs.	Oats per acre, 1844. Qrs. bu. pks.	Straw per acre, 1844. Cwts. lbs.	Value of the crops per acre for two years. L. s. d.	REMARKS.
	No. 4.								
1843	Farm-yard manure	28 0	... ...	9 18 0					1843.—Ploughing oat-stubble, £1, 10s.; cross-ploughing, harrowing, and drilling, £2; seed-potatoes, 15 cwt., £1, 10s.; hoeing and working, £1; lifting and pitting, £1, 5s.; manure, £11, 5s. Total expense, £18, 10s.
	Sulph. of Ammonia	... ...	1 0	0 18 0	16 1 48	... ...	... ...	32 2 4	
	Sulphate of Soda...	... ...	1 56	0 9 0					1844.—Ploughing and harrowing in seed-oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, and barn-work, £1. Total, £2, 12s. Total value for two years, £46, 13s. 10d. Total expense, £21, 2s.; leaving for rent and per-centage on capital, £25, 11s. 10d.
1844	Continued effects...	... ...	... ...	... ...	... ...	9 5 3	48 61	14 11 6	
				11 5 0				46 13 10	
	No. 5.								
1843	Farm-yard manure	28 0	... ...	9 18 0					1843.—Ploughing oat stubble, £1, 10s.; cross-ploughing, harrowing, and drilling, £2; seed-potatoes, 15 cwt., £1, 10s.; hoeing and working, £1; lifting and pitting, £1, 5s.; manure, £13, 4s. Total expense, £20, 9s.
	Bones dissolved....	... ...	6 0	1 8 0					
	Sulphuric Acid......	... ...	2 0	1 8 0	14 5 70	... ...	... ...	28 11 5	1844.—Ploughing and harrowing in seed-oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, and barn-work, £1. Total, £2, 12s. Total value of two years' produce, £41, 15s. 3½d; total expense of two years, £23, 1s.; leaving £18, 14s. 3½d. for rent and per-centage on capital.
	Carbon. Magnesia..	... ...	1 0	0 10 0					
1844	Continued effects...	... ...	... ...	... ...	... ...	8 6 3	43 59	13 3 10½	
				13 4 0				41 15 3½	
	No. 8.								
1843	Farm-yard manure	14 0	... ...	4 19 0	15 15 0	... ...	... ...	31 10 0	1843.—Ploughing oat stubble, £1, 10s.; cross-ploughing, harrowing, and drilling, £2; seed potatoes, 15 cwt., £1, 10s.; hoeing and working, £1; lifting and pitting, £1, 5s.; manure, £7, 14s. Total expense, £14, 19s.
	Peruvian Guano.....	... ...	5 0	2 15 0					
1844	Continued effects...	... ...	... ...	... ...	... ...	8 4 3	47 72	13 6 10½	1844. Ploughing and harrowing in seed-oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, and barn-work, £1. Total, £2, 12s. Total expense of two years, £17, 11s.: total value of two years' produce, £44, 16s. 10½d., leaving £27, 5s. 10½d. for rent and per-centage on capital.
				7 14 0				44 16 10½	

No. IX.

Results of Two Years' Crops on land Manured with Guano and other Special Manures, in 1843 *and* 1844.

Turnips valued at 10s. 6d. per ton; Oats, 2s. 6d. per bushel; Straw at 2s. per cwt.

	Application of manures to the green crop for the rotation.	Quantity of farm-yard manure applied per acre. (Tons cwts.)	Quantity of special manure applied per acre. (Cwts. lbs.)	Cost of manures per acre. 1843. (L. s. d.)	Amount of produce. Turnips per acre, 1843. (Tns. cwts. lbs.)	Oats per acre, 1844. (Qrs. bu. pks.)	Straw per acre, 1844. (Cwt. lbs.)	Value of the crops per acre for two years. (L. s. d.)	REMARKS.
	No. 1.								
1843	Farm-yard manure	25 0	... ...	8 15 0	26 0 0	... ...	... ...	13 0 0	1843.—Ploughing oat stubble, £1, 10s.; cross-ploughing, harrowing, and drilling, £2; turnip-seed, 4 lbs., 4s.; hoeing and thinning, 10s.; topping and tailing, 8s.; driving home, 10s.; manure, £8, 15s. Total, £13, 17s.
1844	Continued effects...	... ...	... ...	... ...	... ...	7 1 3	38 63	11 1 4½	1844.—Ploughing and harrowing in seed oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, and barn-work, £1. Total, £2, 12s. Total expense of two years, £16, 9s.; total value of two years' produce, £24, 1s. 4½d.; leaving £7, 12s 1½d. for rent and per-centage on capital.
				8 15 0				24 1 4½	
	No. 2.								
1843	Farm-yard manure	25 0	... ...	8 15 0	32 0 0	... ...	... ...	16 0 0	1843.—Ploughing oat stubble, £1, 10s.; cross-ploughing, harrowing, and drilling, £2; turnip-seed, 4 lbs., 4s.; hoeing and thinning, 10s.; topping and tailing, 8s.; driving home, 10s.; manure, £9, 15s. Total, £14, 17s.
1843	Burnt Bones.........	... ...	5 0	1 0 0					
1844	Continued effects...	... ...	.. ...	... ...	... ...	8 6 0	37 48	12 7 0	1844.—Ploughing and harrowing in seed-oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, and barn-work, £1. Total, £2, 12s. Total expense for two years, £17, 9s.; total value, £28, 7s.; leaving for rent and per-centage on capital, £10, 18s.
				9 15 0				28 7 0	
	No. 3.								
1843	Farm-yard manure	25 0	... ...	8 15 0	28 0 0	... ...	... ...	14 0 0	1843.—Ploughing oat stubble, £1, 10s.; cross-ploughing, harrowing, and drilling, £2; turnip-seed, 4 lbs., 4s.; hoeing and thinning, 10s.; topping and tailing, 8s.; driving home, 10s.; manure, £9, 13s. Total, £14, 15s.
1843	Sulphate of Soda...	... ...	3 0	0 18 0					
1844	Continued effects...	... ...	... ...	... ...	... ...	7 7 2	39 87	11 18 3	1844.—Ploughing and harrowing in seed-oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, and barn-work, £1. Total, £2, 12s. Total expense of two years; £17, 7s.; total value of two years' produce, £25, 18s. 3d.; leaving for per-centage on capital, and rent, £8, 11s. 3d.
				9 13 0				25 18 3	

No. X.

Results of Two Years' Crops on land Manured with Guano and other Special Manures, in 1843 and 1844.

Turnips valued at 11s. per ton; Oats at 2s. 6d. per bushel; and Straw at 2s. per cwt.

	Application of manures to the green crop for the rotation.	Quantity of Farm-yard manure applied per acre. Tons cwts.	Quantity of special manure applied per acre. Cwts. lbs.	Cost of manures per acre, 1843. L. s. d.	Amount of produce. Turnips per acre, 1843. Tns. cwts. lbs.	Oats per acre, 1844. Qrs. bu. pks.	Straw per acre, 1844. Cwts. lbs.	Value of the crops per acre for two years. L. s. d.	REMARKS.
	No. 4.								
1843	Farm-yard manure	25 0	... ...	8 15 0	21 9 0	... ...	... ...	12 4 6	1843.—Ploughing oat stubble, £1, 10s.; cross-ploughing, harrowing, and drilling, £2; hoeing, thinning, &c., 10s.; turnip-seed, 4 lbs., 4s.; topping and tailing, 8s.; carting home, 10s.; manure, £9, 15s. Total, £14, 17s.
1843	Bone-dust	... ...	5 0	1 0 0					
1844	Continued effects...	... ...	... ...	... ...	... ...	8 3 3	41 37	12 9 10½	1844.—Ploughing and harrowing in seed oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, and barn-work, £1. Total, £2, 12s. Total expense for two years, £17, 9s.; total value of two years, £24, 14. 4½d.; leaving £7, 5s. 4½d. for rent and per-centage on capital.
				9 15				24 14 4½	
	No. 5.								
1843	Farm-yard manure	14 0	... ...	4 18 0	34 2 0	... ...	... ...	17 1 0	1843.—Ploughing oat-stubble, £1, 10s.; cross-ploughing, harrowing, and drilling, £2; hoeing, thinning, &c., 10s.; turnip-seed, 4s.; topping and tailing, 8s.; carting home, 10s.; manure, £6, 11s. Total, £11, 13s.
1843	Peruvian Guano....	... ...	3 0	1 13 0					
1844	Continued effects...	... ...	... ...	... ...	... ...	8 4 3	47 72	13 4 4½	1844.—Ploughing and harrowing in seed-oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, and barn-work, £1. Total, £2, 12s. Total value of two years' produce, £30, 5s. 4½d.; total expense, £14, 5s.; leaving £16, 0s. 4½d. for rent and per-centage on capital.
				6 11 0				30 5 4½	
	No. 6.								
1843	Compost............	... ...	bu. 64 0	1 11 0	25 3 0	... ...	... ...	12 11 6	1843.—Ploughing oat-stubble, £1, 10s.; cross-ploughing, harrowing, and drilling, £2; hoeing, thinning, &c., 10s.; turnip-seed, 4 lbs., 4s.; topping and tailing, 8s.; carting home, 10s.; manure, £1, 11s. Total, £6, 13s.
1844	Continued effects...	... ...	... ...	... ...	... ...	6 3 0	32 59	9 12 6	1844.—Ploughing and harrowing in seed-oats, £1; 4 bushels seed-oats, 12s.; cutting, stacking, and barn-work, £1. Total, £2, 12s. Total value of two years' produce, £22, 4s.; total expense, £9, 5s.; leaving £12, 19s. for rent and interest on capital.
				1 11 0				22 4 0	

No. X.

Results of Two Years' Crops on land Manured with Guano and other Special Manures, in 1843 and 1844.

Potatoes, 40s. per ton; Barley, 3s. 6d. per bushel; Straw, 1s. 6d. per cwt.

	Application of manures to the green crop for the rotation.	Quantity of farm-yard manure applied per acre.	Quantity of special manure applied per acre.	Cost of manures per acre, 1843.	Amount of produce. Potatoes per acre, 1843.	Barley per acre, 1844.	Straw per acre, 1844.	Value of the crops per acre for two years.	REMARKS.
		Tons cwts.	Cwts. lbs.	L. s. d.	Tns. cwts. lbs.	Qrs. bu. pks.	Cwts. lbs.	L. s. d.	
	No 1.								
1843	Farm-yard manure	30 0	... ...	10 10 0	14 0 0	... ...	... ...	28 0 0	1843.—Trenching lea, £3, 6s. 8d.; seed-potatoes, 15 cwt., £1, 10s.; planting, hoeing, &c., £2; lifting and pitting, £1, 5s.; manure, £10, 10s. Total, £18, 11s. 8d. 1844.—Ploughing and harrowing in seed-barley, £1; 4 bushels seed-barley, at 4s. per bushel, 16s.; cutting, stacking, and barn-work, £1, 3s. Total, £2, 19s. Total expense for three years, £21, 10s. 8d.; total value of two years' crops, £42, 14s. 1½d.; leaving £21, 3s. 5½d. for rent, and per-centage on capital.
1844	Continued effects—	... ...	... ...	... ...	... ...	7 7 1	48 64	14 14 1½	
				10 10 0				42 14 1½	
	No. 2.								
1843	Farm-yard manure	14 0	... ...	4 19 0	16 0 0	... ...	... .	32 0 0	1843.—Trenching lea, £3, 6s. 8d.; seed-potatoes, 15 cwt., £1, 10s.; planting, hoeing, &c, £2; lifting and pitting, £1, 5s.; manure, £6, 12s. Total, £14, 13s. 8d. 1844.—Ploughing and harrowing in seed-barley, £1; 4 bushels seed-barley at 4s. per bushel, 16s.; cutting, stacking, and barn-work, £1, 3s.; total, £2, 19s. Total expense of two years, £17, 12s. 8d.; total value of two years' crops, £17, 6s. 3d.; leaving £29, 13s. 7d. for rent and per-centage on capital.
	Peruvian Guano.—	... ...	3 0	1 13 0					
1844	Continued effects—	... ...	... ...	... ...	... ...	8 4 2	45 48	15 6 3	
				6 12 0				47 6 3	
	No 3.								
1843	Farm-yard manure	14 0	... ...	4 19 0	18 5 0	... ...	... ...	36 10 0	1843. Trenching lea, £3, 6s. 8d.; seed-potatoes, 15 cwt., £1, 10s.; planting, hoeing, &c, £2; lifting and pitting, £1, 5s.; manure, £6, 18s. 6d. Total, £15, 0s. 2d. 1844.—Ploughing and harrowing in seed-barley, £1; 4 bushels seed-barley at 4s. per bushel, 16s.; cutting, stacking, and barn-work, £1, 3s. Total, £2. 19s. Total value of two years' produce, £51, 3s. 3d.; total expenses, £17, 19s. 2d.; leaving £33, 4s. 1d. for rent and per-centage on capital.
	Peruvian Guano.—	... ...	3 0	1 13 0					
	Sulphate Magnesia.	... ...	0 56	0 4 0					
	Gypsum.............	... ...	1 0	0 2 6					
1844	Continued effects...	... ...	... ...	... ...	... ...	8 1 3	42 96	14 13 3	
				6 18 6				51 3 3	

EXPERIMENTS WITH LINSEED CAKE AND OTHER SUBSTANCES, IN FATTENING SHEEP AND CATTLE.

By Mr Bruce, Waughton, East Lothian.

[Premium, Five Sovereigns.]

Having made use of a large quantity of linseed-cake for the last two or three years in fattening live stock, and being a little doubtful of its use giving a profitable return, the following experiments were conducted with the view of ascertaining its value, 1st, as an article of food, and 2d, as a manure, when consumed upon the farm.

Experiment I.

For these ends, 27 small polled heifers were divided into three lots and weighed; one lot being put on a liberal allowance of home-made cake, another upon foreign, (to determine which of the two was the more profitable for use), and the other upon turnips alone. The experiment, which was carried on for nine weeks, was fully completed, both as regarded the improvement made by the animals, and the saving effected in the consumption of food; but, unfortunately, some of the heifers having turned out in calf, the results connected with them were rendered much less satisfactory, and are therefore precluded; though, such as they were, they yielded a greatly inferior return to that made by sheep in a similar experiment.

With regard to the second part of the experiment, viz., the value of linseed-cake as a manure when consumed in the court-yard, the following are its results:—The dung made from the animals receiving the cake, being kept in a heap by itself, was tested with a similar quantity, made at the same time, by another lot of cattle in a different yard, all of them receiving a full supply of stored Swedish turnips; attention being paid both to the preparation and decomposition of the manures, in order to have them as nearly as possible alike. The dung-heap from the cake contained 144 cubic yards, to produce which had been consumed 3744 lbs. of cake, (equal weights of home and foreign), thus giving 26 lbs. of cake to the cubic yard. The dung so prepared was then applied to three different fields of Swedish turnips, at the rate of 16 cart-loads per acre, each cart containing 1½ cubic yards, without the addition of any other manure. Shortly after the plants were singled, those from the cake manure showed themselves more in

advance than others in the same fields, and kept a decided superiority over them during the early part of the season, thereby giving hopes of a larger return than was ultimately realized. On the 27th December, an equal quantity of land in each field, consisting of the eighth part of an acre, was taken up and weighed, the roots and tops being taken off, when the average of the three fields was found to be as follows:—

Quantity of land in parts of an acre.	Weight from cake manure.	Weight from common manure.	Increase from cake.	Weight of cake consumed.	Cost of production per cwt.
	lbs.	lbs.	lbs.	lbs.	lbs.
.125	5090*	4650	440	78	19¾

To test the value of linseed-cake still further, but by a different method, two lots of sheep, of 60 each, were taken from two flocks that were feeding upon the farm, and each lot was then separated into three divisions and weighed: 20 being put on home cake, 20 on foreign, and 20 on turnips alone. A part of two fields of Swedish turnips was next selected, where they presented a uniformity of soil and crop, one half of the crop, in both fields, having been carried home. The two parts thus selected, were then each didivided into three equal portions with a chain, and 20 sheep put into each portion. Lot 1st consisted of 60 half-bred Dinmonts of good quality, which, to simplify details, may be distinguished by A, B, and C; division A consuming the home-cake, B the foreign, and C turnips alone. The respective weights of the sheep on the 1st of January 1844, when the experiment commenced, were—of division A 2768, of B 2739, of C 2803 lbs.; on the 7th of Februrary, C having consumed its portion of turnips, was then re-weighed, and found to be 2880 lbs., and on the first March, A and B having also consumed theirs, were found to be, A 3054, B 2966 lbs. The quantity of cake consumed by each division, was 1182 lbs., being nearly 16 oz. per day to each. Lot 2d consisted of 60 Cheviot Dinmonts of inferior quality, whose respective divisions may be designated by D, E, and F; D getting home-cake, E foreign, and F turnips alone. The management pursued in this case was in every respect similar to that for lot 1st, with the exception of the quantity of cake consumed, which amounted to 44 lbs. per sheep, being at the rate of fully 13 oz. per day to each, an allowance which it was found they would not exceed. On the 9th of January, when the experiment commenced, their respective weights

* It would be wrong, however, to confine the value of this manure, so rich in the phosphates, to its effect upon an alkaline plant.

were—D 2082, E 2001, and F 2031 lbs. On the 15th February, F, having finished its portion, weighed 2097 lbs., and on the 2d March, D and E, having also finished theirs, weighed—D 2315, and E 2274 lbs. The two cake divisions in each lot consuming the same quantity of turnips.

Tabular view of the improvement made by the different divisions.

		Weight at first	Weight at last	Incr	Incr from cake	Wt of cake consumed	Cost of production per lb
		lbs	lbs	lbs	lbs.	lbs	oz.
Lot 1st	A	2768	3054	286	209	1182	66
	B	2739	2966	227	150	1182	83¼
	C	2803	2880	77	...	...	...
Lot 2d	D	2082	2315	233	167	880	60¼
	E	2001	2274	273	207	880	51½
	F	2031	2097	66	...	...	... *

It will be observed from the foregoing table, that the improvement made by C and F is below an average; this, however, would have been anticipated by any person having the least experience in the management of sheep, from the peculiar manner it was necessary to confine them, for the purpose of ascertaining the value of the cake as a manure upon the future crop. Indeed, the treatment altogether was necessarily unfavourable to sheep; but as each division laboured under the same disadvantage, the management does not therefore detract in the least from the value of the experiment. It will be noticed, also, that the improvement made by A and D on the home-cake, and B and E on the foreign, is exactly reversed in the different fields, a circumstance which cannot in any way be accounted for.

The last part of this experiment now falls to be considered, viz., the value of linseed-cake as a manure, when consumed upon the ground by sheep,—the produce of one field only being given, though the effect produced upon the two cake divisions in the other, presented an equally marked and favourable appearance.

Early in March, the land was sown with wheat, reaped by the 20th of September, and thrashed on the 21st December, when the produce of the different divisions was found to be as follows, the grain being all properly cleaned of refuse, but not separated into first and second quality:—

* With regard to the increased live weight of the sheep, it is quite clear, that, however much the animal is improved, its waste or refuse remains unaltered, consequently, whatever is gained must be of real value.

Tabular view of the Produce of the different Lots.

Lots.	Quantity of land in acres.	Weight of grain.	Weight per bush.	Incr. of grain from cake.	Weight of straw.	Incr. of straw from cake.	Wt. of cake consumed.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
A	1.041	2248	61½	288	3723	817	1182
B	1.041	2223	61½	263	3506	600	1182
C	1.041	1960	62½	...	2906	...	...*

Experiment II.

This was an experiment carried on during the latter part of 1844, for the purpose of ascertaining the relative value of the following articles in the fattening of sheep, viz., linseed, linseed-cake, poppy-cake, beans, and a mixture of beans and linseed. The sheep selected for this purpose consisted of 95 Cheviot ewes, taken from a flock of 250, which had reared their lambs during the summer, and were of fair quality when the experiment commenced, but from the greater part of them wanting teeth, and, consequently, unable to break the turnips, they were supplied instead, with a full allowance of turnip tops, (except for a few days afterwards specified,) in addition to the different articles used, a circumstance which tends to enhance the value of the experiment, as, from the worthless nature of turnip tops in fattening, any improvement made by the animals must be almost entirely attributed to the qualities of the foreign substances used.

The different lots, which consisted of four of 20, and one of 15, sheep, may be classed as A, B, C, D, and E. Lot A, containing the 15, were put upon the linseed, having reduced the number as much as was consistent with accuracy for the experiment, from an apprehension that linseed would not tend to improve the animals, on account of the large quantity of oil it contains † acting too powerfully upon their systems, a fear, however, which had no foundation, as they kept throughout in as healthy and natural a state, as if feeding upon grass. Lot B was put upon the linseed-cake, and received the same quantity as D upon the beans; C was put upon a mixture of beans and linseed for the first three weeks, and afterwards upon the poppy-cake, and E

* In addition to the above return, a further allowance ought to be made for unexhausted manure.

† Linseed of fine quality, weighing 52 lbs. per bushel, such as was used in this experiment, readily yields from 11 to 12 gallons of oil per quarter, weighing 9 lbs. per gallon, or about 25 per cent. of its weight.

upon a mixture of beans and linseed. All the several lots being enclosed upon small portions of grass land equally sheltered, had as impartial justice done them in the management as it was possible to effect. The quantity given at first of the different articles, was smaller than indicated by the average consumption, and was gradually increased to as much as each division would freely consume. The time, also, which this experiment was carried on, was limited to what was considered the most proper for getting the greatest retun from the articles used. The results are as follow:—

	Weighed 21st Oct.	Weighed 12 Nov.	Increase.	Weighed 23d Dec	Increase.	Average consumption by each sheep, per week.	Average improvement of each sheep, per week.	Cost of production, per lb.	Total Consumption.
Lots.	lbs.	lbs.	lbs.	lbs.	lbs.	oz.	oz.	oz.	lbs.
A	1839	...	...	2008	169	56½ Linseed.	20	40½ Linseed.*	477 Linseed.
...	...	...	...	...	...	4¼ Beans.	...	... ...	36 Beans.
B	2401	...	...	2303	202	113¼ Linseed cake.	18	101 Linseed cake.	1275 Linseed cake.
C	2382	2479	97	...	...	95½ Beans and Linseed.	25¾	59 Beans and Linseed.	310 Beans.
...	...	...	...	...	...	... ...	...	... ...	48 Linseed.
...	...	...	...	2657	178	157¼ Poppy-cake.	23¾	106 Poppy-cake.	1180 Poppy-cake.
D	2404	...	...	2557	153	113¼ Beans	13½	133¼ Beans.	1275 Beans.
E	2417	...	...	2736	319	100 Beans and Linseed.	28¼	56¼ Beans and Linseed.	702 Beans. 422 Linseed.

* In calculating the cost of production per lb. of division A, 5 lbs. have been deducted for the 36 lbs. beans consumed, these having been given to the sheep to induce them to eat the linseed, which had acquired a musty smell from lying in a ground state.

The linseed used during the experiment was ground, but from the great difficulty in doing so, several trials were made after it was completed, to ascertain the loss attending its use in a whole state — by supplying a lot of the sheep with unground seed, confining them to clean spots of ground—carefully collecting their droppings,—subjecting it to a series of washings,—evaporating the residue to dryness, and then weighing it, when the loss was found to be under one per cent.

The following figures will represent thequality of the linseed-cake used, assuming the number 8 as the average quality of that made at Hull:—

Home used in No. 1, ...	8¼
Foreign, in do.	7½
Do., in No. 2, ...	7¾
Poppy-cake of good quality.	

Experiment III.

The following experiment was carried on during the progress of that of No. II.—

The turnip tops upon the farm having been all consumed by the 15th November previous to commencing storing the Swedish turnips, the opportunity was taken for making a trial to ascertain the saving effected by the use of the different articles—an important consideration with the farmer. For this purpose 20 additional ewes were taken from the same flock, and enclosed separately for eight days; during which time the six divisions were supplied with a full allowance of white turnips, which were duly weighed (without roots and tops) and cut upon the grass; the refuse was afterwards carefully collected, re-weighed, and deducted, so that the actual consumption is only given.

The results of this trial are thus shown:—

	Consumption of turnips.	Consumption of foreign keep.	Consumption of each sheep, per day.		Saving of turnips.	Amounting to per cent.
			Turnips	Foreign Keep.		
Div	lbs	lbs	lbs.	lbs.	lbs.	
A	1782	32 Linseed.	14¾	7 Linseed.	839	32½
...	...	3 Beans.		½ Beans.		
B	1781	200 Linseed-cake	11¼	20 Linseed-cake.	1741	49¼
C	2402	280 Poppy-cake.	15	28 Poppy-cake.	1120	31¾
D	2312	200 Beans.	14½	20 Beans.	1210	34¼
E	2699	100 Beans.	16¾	10 Beans.	823	23¼
...	...	60 Linseed.		6 Linseed.		
F	3522	... ...	22	...	...	...

It will be observed from this table, that the saving of turnips effected in division B, is great, and seems a larger proportion for the twenty ounces of linseed-cake, than Experiment I. gave in its quantities; but much, no doubt, will depend upon the size and condition of the sheep, as the lower the condition, the greater will be the quantity of food consumed. It may be held as a safe calculation, that sixteen ounces of good linseed-cake per day to sheep of nine stone weight, will effect a saving in the consumption of turnips equal to 33 per cent., and at the same time so far improve the health of the animals as to diminish the number of deaths by upwards of 50 per cent.

Experiment IV.

In order to ascertain if the use of the different articles in Experiment II., produced any difference as to tallow, five average ewes were selected from each division and weighed; two days afterwards they were killed and weighed under the inspection of the reporter, having been driven, in the interval, twenty-three miles.

The following table exhibits the results—

	Live weight Dec 23.	Weight of Carcass, Dec. 25.	Weight of Tallow.	Weight of Skins.
Lots.	lbs.	lbs.	lbs.	lbs.
A	666	344	55	52
B	647	335	57	57
C	654	338	57	57
D	641	327	49	52
E	688	347	61	50

These experiments having been conducted with a view to personal information, a strict regard to accuracy was observed in every detail, and though conducted upon rather a limited scale, they clearly establish the fact, that mutton can be produced at a lower rate per lb., upon a liberal use of foreign keep along with turnips, than upon turnips alone, taking of course the increased value of the manure into account; and that of the different articles used in Experiment II., linseed is the most valuable, and beans the least so, but that a mixture of both forms a useful and nutritious article of food.

REPORT ON THE CONTINUED EFFECTS OF CERTAIN SPECIAL MANURES.

Communicated by the Turiff Agricultural Association.

Drawn up by Mr ALEXANDER MURRAY, Nethermill of Cruden.

I. FARM, SLAP; TENANT, MR WILLIAM MURRAY.—CROP 1845.

Table of Results on New Grass, Third Year of the Rotation.

No	MANURES	Dry Weight per Imperial acre.			Increase of Dry Weight per Imperial acre		
		cwt.	qr.	lb	cwt	qr	lb
1	Bone-dust	21	1	12	9	1	20
2	Bone-dust and Sulph. Acid	19	2	4	7	2	12
3	Guano	15	2	4	3	2	12
4	Farm-yard Manure	18	3	20	7	0	0
5	No Application	11	3	20	...	...	...
6	Farm-yard Manure and Bone-dust.	22	1	20	10	2	0
7	Farm-yard Manure and Bone-Dust, and Sulph Acid	19	1	8	7	1	6
8	Farm-yard Manure and Guano	22	0	0	10	0	8
9	Peat and Saline Manures	17	0	16	5	0	24
10	Farm-yard Man. and Saline Man.	21	1	24	9	2	24

The Grass was cut on 15th July, and weighed on 28th August.

OBSERVATIONS.

July 8th.—No. 1. Rye-grass, dark green, short and bushy; white clover abundant.

2. Very similar to No. 1.
3. Rye-grass strong, not so bushy as Nos. 1 and 2, nor equal in white clover.
4. Better than Nos 1, 2, and 3 in rye-grass and red clover—but not equal to Nos. 1 and 2 in white clover.
5. Worst on the field—very inferior.
6. Rye-grass good—rich in white clover.
7. Equal to No. 6.
8. Inferior to Nos. 6 and 7.
9. Not equal to No. 8.
10. Rather better than No. 5—inferior to all the others.

August 28th.—The hay was prepared in the English method, and great attention was paid to it in consequence of rainy weather at the time, which delayed the weighing. It was quite dry at the time of weighing. The aftermath was very inferior. It was depastured with cattle. The grass, after farm-yard manure, showed some superiority over the others.

II. Farm, Findon; Tenant, Mr James Strachan.—Crop 1845.

Table of Results on New Grass, Third Year of the Rotation.

No.	Manures.	Dry Weight per Imperial acre.			Increase per Imperial acre.			Decrease per Imperial acre.		
		cwt.	qr.	lb.	cwt.	qr.	lb.	cwt.	qr.	lb.
1	Bone-dust	40	2	8	0	0	10	...	...	...
2	Bone-dust and Sulph. Acid	39	1	4	...	...	...	1	0	22
3	Guano	42	0	24	1	2	26	...	...	...
4	Farm-yard Manure	40	3	8	0	1	10	...	...	...
5	No Application	40	1	26	...	...	...	...	...	...
6	Farm-yd. Man. and Bone-dust	44	0	10	3	2	12	...	...	...
7	Farm-yard Man. and Bone-dust, and Sulph. Acid	39	3	10	...	...	...	0	2	16
8	Farm-yard Man. and Guano	40	2	24	0	0	26	...	...	...
9	Peat and Saline Manures	36	3	21	...	...	...	3	2	5
10	Fm.-yd. Man. and Saline Man.	40	2	4	0	0	6	...	...	...

The Grass was cut on 8th July, and weighed on 1st September.

Observations.

Scarcely any difference could be observed on any of the experimental plots throughout the summer. The rye-grass, and red and white clover, were luxuriant and well mixed. The hay was made in the English method, and care was taken to have it properly dried before it was weighed.

The aftermath was short, and depastured by cattle. No apparent difference could yet be detected.

III. Farm, Rothiebrisbane; Tenant, Charles Chalmers, Esq. of Monkshill. Crop 1845.

Table of Results on New Grass, Third Year of the Rotation.

No.	Manures.	Dry Weight per Imperial acre.			Increase per Imperial acre.		
		cwt.	qr.	lb.	cwt.	qr.	lb.
1	Bone-dust	23	0	16	15	1	1
2	Bone-dust and Sulphuric Acid	25	0	6	17	0	19
3	Guano	21	3	8	13	3	21
4	Farm-yard Manure	22	2	20	14	3	5
5	No Application	7	3	15	...	...	...
6	Farm-yd. Manure and Bone-dust	22	1	16	14	2	1
7	Farm-yd. Man., Bone-dust, and Sulphuric Acid	20	1	22	12	2	7
8	Farm-yd. Manure and Guano	22	3	7	14	3	20
9	Peat and Saline Manures	15	0	20	7	1	5
10	Farm-yd. Manure and Saline Man.	16	0	16	8	1	1

The grass was cut on 17th July, and weighed on 5th August.

Observations.

July 4.—1. Rye-grass short, but green and bushy, with a thick sole of white clover.

2. Similar to No. 1—light crop of red clover.
3. Sole of rye-grass—inferior to Nos. 1 and 2—deficient in white clover.
4. Rye-grass stronger than on Nos. 1, 2, or 3—white clover better than No. 3, but inferior to Nos. 1 and 2.
5. Decidedly worst on the field—very short and open sole of grass.
6. Similar to No 4.
7. Rather better in white clover than No. 6.
8. Scarcely equal to Nos 6 and 7, but better than No. 3.
9. Rather better than No. 5, but inferior to all the others.
10. A very little better sole of grass than No. 9.

From the result of the three years' experiments, of the rotation, the following conclusions may be drawn:—

1st, Farm-yard manure with guano, seem to give the greatest bulk of crop, and a heavier crop than a full manuring of either alone.

2d, Farm yard manure with bone-dust, or bone-dust and sulphuric acid, produce heavier crops of turnips and oats than a full manuring of either alone.

3d, Notwithstanding the weight of hay crop, after the bone-dust, or bone-dust and sulphuric acid, appears about equal to that raised by the other applications, still they uniformly produce the best sole of rye-grass and white clover. This may be accounted for in two ways. 1st, Much more phosphates are added to the soil by a full manuring of bone-dust, or bone-dust and sulphuric acid, than from farm-yard manure or guano. The same result holds good with mixtures of these. 2d. The texture of the soil is much firmer in the turnip crop after bone-dust, or bone-dust and sulphuric acid, than after farm-yard manure or guano. Now, experiment and experience have proved, of late years, that the texture of the soil has much influence in the growth of clover.

4th, The addition of sulphuric acid to bone-dust, appears to accelerate the growth of vegetables. This is an important circumstance for wet cold clay soils. I find, that a less quantity of sulphuric acid along with bone-dust, than that used by the Turriff experiments—say, 6 lbs. instead of 25 lbs. to the bushel, has all the advantages of early action, and is free from the objections to so large a proportion.

5th, With regard to farm-yard manure, or peat and saline manures, they fall behind the other applications after the first year. This may arise from the saline manures being easily dissolved, and thereby early appropriated by the plants.

ON THE CULTIVATION OF THE RED CLOVER, AND THE CAUSES OF ITS FAILURE.

By Robert M'Turk, Esq. of Hastings Hall, Dumfries-shire.

[Premium, Medium Gold Medal]

It is a fact well authenticated in the practice of agriculture, that when the same variety of crop has been cultivated on the same field for a number of years consecutively, or even at short intervals, the land ceases to yield the same weight as in the first years of cultivation; and it is upon a knowledge of this fact, that a systematic alternation of crops is regarded as essential to every system of good husbandry. When this important principle is neglected, deterioration in the soil invariably ensues, and then its previous fertility can only be restored by a greater expenditure of manure, and a stricter adherence to a well arranged rotation for the future.

With regard to the cause and nature of this deterioration, much difference of opinion has, and does, even at the present time, prevail; and men of the highest scientific attainments, who have devoted a portion of their time to its consideration, are nearly equally divided in opinion. The purely practical man readily assents to the truth of deterioration, by adopting such a rotation of crops, and system of cultivation as he judges most likely, not only to prevent further deterioration, but to maintain the soil of his farm in a state of progressive improvement. Still, he is at a loss to assign a reason, in every respect satisfactory even to himself, as to the necessity for any particular succession of crops.

The red clover may, with propriety, be selected as the crop in which this deterioration has, for many years back, been more apparent than in any other. The observation, however, is not confined to this crop, but is applicable to almost every other in general cultivation.

The question, then, as to the inducing cause of the deterioration in the soil, assumes an aspect of more general importance than the deficiency in the clover crop alone; and its discussion can scarcely fail to throw some light on a subject which seems to be involved in mystery, perhaps the more from the speculative views entertained on it by men whose opinions on other subjects are entitled to the utmost respect. Before proceeding to adduce the results of our own experience, it may not be out of place to state here, shortly but generally, the theories which have been advanced by two parties, who both think they see, in the views they entertain, a satisfactory explanation of a difficulty so intimately connected with the fruitfulness of the soil.

First, then, one party maintains that the necessity for an alternation of crops is owing to a function exercised by plants,

by means of which they excrete or discharge from their roots, such substances as they do not require, or cannot assimilate, and that the substances so excreted, deteriorate or unfit the soil, for a time, for the healthy growth of plants of the same variety; but, although unfitted for the growth of plants of the same variety, others of a different kind will, in these excretions, find the means of nourishment; and, when appropriated by them, the soil will again be restored to its original fertility. Hence, the evident necessity for a rotation of crops.

Another cause for the diminished fertility of the soil is assigned, and, we think, more justly, by the other party: that after he peated cultivation of the same variety of plants, the soil, to a certain extent, becomes exhausted of those substanees upon which those kinds of plants chiefly depend for nourishment, and which are essential to the full development of their parts. Both views have their advocates, and been ably supported.

The experiments of Becquerel and Matiucci,* with regard to the appearance of acetic acid in the soil after the growth of barley, where it did not previously exist, may be regarded as the groundwork of the theory of radical excretions. It was first broached by Bergmann, and afterwards warmly supported by Decandolle,† as sufficiently accounting for the necessity of a systematic rotation of crops in the practice of agriculture.

The experiments of Macaire Princep,‡ and the subsequent observations of Neitner, seem to have led them to adopt the same views. Liebig sees in the theory of Decandolle, and in the experiments of Macaire, a satisfactory explanation of the advantage, (in an agricultural point of view), arising from a regular alternation of crops. "Of all the views," says Liebig, "which have been adopted regarding the cause of the favourable effects of the alternation of crops, that proposed by M. Decandolle deserves to be mentioned, as resting upon a firm basis."‖ In illustration of the same doctrine, he also says, "In some neighbourhoods, clover will not thrive till the sixth year, in others, not till the twelfth,—flax, in the second or third year."

All this depends upon the chemical nature of the soil; for it has been found by experience, that in those districts where the intervals at which the same plants can be cultivated with advantage, are very long, the time cannot be shortened even by the use of the most powerful manures. The destruction of the peculiar excrement of one crop, must be effected before the production of a new crop.§ The same views are also entertained by Macaire, Neitner, and other physiologists of distinction. Bra-

* Ann. de Chim. et de Phy. xlv. p. 310. † Edin. Phil. Journal, 1833, vol. xiv.
‡ Ann. de Chim. et de Phy. lii. p. 225. ‖ Agric. Chem. p. 152 and 157.
§ Ann. de Chim. et de Phy. lxxii. p. 27.

connet, by a series of experiments similar to those of Macaire, has arrived at a very different conclusion, and has also endeavoured to point out the fallacy by which Macaire, in his experiments, was misled, and indeed furnishes us with such an explanation of the phenomena exhibited by these experiments, as would seem to show, that the root does not possess the power of excreting matter, or at all events, in sufficient quantity to affect the growth of plants of the same variety. So late as 1842, Mr Gyde, Painswick, Gloucestershire, received a premium from the Highland and Agricultural Society, for a paper on this very subject.

Mr Gyde's experiments seem to have been conducted with as much attention to accuracy, as any of those to which we have previously alluded; and if they are conclusive as to the fact, that plants do possess the power of excreting matter from their roots, they are equally so, as to the innocuous nature of these substances, under the particular circumstances in which they are produced.

The following are Mr Gyde's conclusions:—

1st, That most plants impart to water certain soluble substances or excretions.

2d, That this is identical with the sap of the plants.

3d, That plants have no power of selection, but take into their texture any solution offered to their roots; and that they have little or no power of again excreting it.

4th, That plants watered with their own excretions receive no injury from them.

With regard to the second of these, we did not find that the excretions were soluble in water. On the contrary, we found that the matter which we regarded as an excretion, was quite insoluble for a time after it was excreted in water at the ordinary temperature of the soil; that it was of greater specific gravity than the water; and that it adhered for some days to the part of the root from which it was excreted, till it accumulated in sufficient abundance for its own weight to carry it to the bottom of the vessel. We also found, that this matter was formed in greater quantity on the newest part of the root, the older having ceased to excrete, but still continuing to infuse as much of its substance into the water, as to impart its peculiar smell and flavour. But this will also happen if any portion of the stem or leaf of a plant is immersed in water. even when the roots are in another vessel. We found that the matter thus communicated to the water possessed more of the characteristics of the true sap, than the flocculent and insoluble matter excreted from the roots.

As to the third conclusion, we readily admit, that when plants are placed in water holding in solution any deleterious substance, they do not seem to possess the power of separating the water from the poisonous matter, and both are received into their system; but it is also true, that if a plant is so placed, as to stand equally upon two kinds of soil, the one consisting of barren, but at the same time permeable till, and the other of

good soil, rich in manure, both divisions of the roots will, in the course of time, leave the barren soil, and take entire possession of the fertile; and further, when compost or soil, particularly rich, is placed on the surface above the roots, a portion of these, in various plants, will forsake their downward course, and rise up to occupy the compost above the surface.

We quite agree with the fourth deduction, that plants receive no injury when watered with their own excretions. Indeed, it accords entirely with one of the best established truths in vegetable nutrition, viz., that no substance can be received by the spongioles of the roots, unless first dissolved in water. For if the matter excreted is really soluble, and is identical with the sap, as stated by Mr Gyde, it is then food in a higher state of assimilation than any plant under ordinary circumstances can meet with in the soil. No wonder, then, that the plants to which Mr Gyde applied the water containing the excretions, grew more vigorously than the other plants, the food of which had received no previous elaboration. More than enough, however, has already been said, with regard to a doctrine which we believe has only tended to mislead enquirers from the path in which truth is to be found and for the refutation of which, we shall only at present advance one argument—for the truth of which we can appeal to the experience of every cultivator of the soil.

The power possessed, or supposed to be possessed, by plants, of discharging from their roots what they do not seem to require, is regarded by all the advocates of the theory of radical excretion, and uniformly represented by them, as a healthy function, one with which the thriving of the plant is connected; and, by some who have adopted these views, as scarcely less essential to their health than the analogous functions are to the well-being of the animal system.

Now, it is a truth, to which there are few exceptions, that all healthy functions are exercised in animals and vegetables, with a degree of regularity and vigour in proportion to the health of the animal, or the luxuriance of the plant. For example; can it for a moment be supposed that any plant can be in a less healthy condition when the leaves are exhaling oxygen by day, and carbonic acid by night, and when the flower is perfuming the air with its fragrance, than when these functions have ceased? No, these are indications of health; and if the roots do excrete, as our own experience tells us they do, the excretion must be produced in quantities proportionate to the luxuriant state of the plant. Is it not, then, a fact well known to every practical man, that his crops grow more luxuriantly, and yield him a more abundant return for his labour, on a fertile soil than on one of a less fruitful character; that the same description of crop can be produced in a healthy condition, for a greater number of years in

succession, in a rich than in a poor soil? In some of the new and rich soils of America, it was no uncommon thing for the first cultivators to take twenty crops of wheat in succession, often many more; and there are instances on record of a hundred being taken in the state of Virginia. In the memory of men with whom we have conversed, ten crops of oats have been taken in immediate succession from land with which we are well acquainted. Now, were it true that the substances excreted from the roots were of a poisonous or injurious nature, it is clear that in the soils in which plants grow most vigorously, these substances would be produced in the greatest abundance, and, consequently, that a good and fertile soil would sooner be poisoned or unfitted for the growth of plants of the same variety, than one of an inferior quality. Can any doctrine, then, be more thoroughly at variance with truth and our every-day experience, than that the necessity for a systematic rotation of crops should be owing to the injurious nature of the substances excreted from the roots of the plants which we cultivate?

We have been more desirous of producing these views, since the red clover is constantly selected as an illustration of the doctrine which we have been combating, as one of the crops, the excretion of which requires a longer time to be decomposed and removed from the soil than any other. To what, then, are we to attribute the failure of this crop, which for many years, in some districts, has been so apparent, that other agricultural associations, as well as the Highland and Agricultural Society of Scotland, have regarded it as an object worthy of investigation.

The Rev. W. Thorp, Warmsley, near Pontefract, in a paper in the third volume of the Journal of the Royal Agricultural Society of England, imputes the failure wholly "*to a want of a certain degree of cohesiveness in the particles of the soil.*" Hence the soil's power of retaining heat is diminished; and all plants, particularly clover, which are impatient of sudden changes of temperature, are thus easily destroyed by the frost.

While we are quite satisfied, from our own observations, that many clover plants are destroyed by the occasional severity of the frost in winter, we cannot agree with Mr Thorp in thinking that this is wholly owing to the want of cohesiveness or solidity in the soil. If we look, however, a little more closely into the theory of the cohesiveness of the soil, as tending to afford a greater degree of protection from frost, (for his whole argument resolves itself into that as the means by which the failure of the crop is to be prevented,) this greater degree of protection cannot be applied to any part of the plant with so much advantage as to that which is most liable to be affected, and in which, according to Mr Thorp, the injury always first makes it appearance. He says, "the first part injured is the neck of the plant (collet,)

about a quarter of an inch below the part where the leaves first join the stem."

How far, then, are the means recommended likely to promote the adhesiveness of the soil, and likely to afford protection against severe frost? for it is only when the weather can be regarded as such that clover plants are injured. Mr Thorp tells us that eating off the turnip crop with sheep will give the necessary degree of solidity; that the turning of the horses upon the end ridges will also impart solidity to them; that the Duke of Portland found that land manured with bones was not sufficiently solid, but that the same, when manured with farm-yard dung, was adhesive enough; that if stubble land is simply scratched with a light harrow before sowing the seed, and afterwards compressed with a heavy roller, it will stand the winter. There are various other expedients recommended by the rev. gentleman, which are not generally under the command of every person, but none of which are regarded as of more importance than those already mentioned. It would, indeed, be a most important advantage if sheep, in addition to the benefit which they otherwise convey to the land when consuming the green crop upon it, (now that the practice is become so general) were also to ensure a good crop of red clover for the two following seasons.

But we cannot think that it was in consequence of the treading of the sheep merely, in the instances to which Mr Thorp alludes, that the abundant crops were to be attributed. We find a much more satisfactory cause in the manure which they left upon the ground. In one field to which we devoted much attention, the turnip crop of which was eaten down with sheep, and through which we had occasion to cart a quantity of stones and other articles, the clover crop afterwards was a complete failure, except on one ridge next to a dyke which sheltered it from the west, the direction in which the field was most exposed to wind and rain, and to which the sheep had constant recourse for shelter, when the weather was unfavourable. This ridge, from the quantity of rain that fell at the time, was certainly not more consolidated than the end ridges on which the turnings were made, or the part over which the road passed; still the crop in those parts seemed to derive no advantage from the compression which they had received, and it was only upon the ridge on which a much larger proportion of dung and urine had been deposited, that the clover could not be regarded as a failure.

We adduce this instance, not only as a case in point, but as coinciding with what may be regarded as the general experience on this subject, of the district in which we reside.

It is true that lime, and more especially in a caustic state, by the decomposition which it promotes in the soil, does to a certain extent render it more porous, but certainly not more so than

farm-yard manure, the action of which, in the state in which it is generally used, is much more active than lime, and bones are less active than either.

As to the other expedient to which we have referred, namely, sowing the clover after the oat or barley crop has been cut—first harrowing the surface, and afterwards rolling in the seeds, we have only to say, that in portions of our fields where the crop has been lodged, and the grass seeds destroyed, we have tried the plan recommended, but the experiment was not attended with that success which would warrant us in advising others to have recourse to it, unless on such parts as we refer to, and which would otherwise produce nothing. On such occasions the seed always germinated well, and showed a thriving *braird*, but the plants were sure to give way, particularly the red clover, when frost commenced. In some instances the clover was destroyed before the frost commenced, for young braird at that season of the year is very palatable to every kind of stock, and is, on that account, sure to be cropt by every kind of stock on the ground, and when once stripped of its leaves, so tender a plant is nipt by the first frost. The recommendation to substitute a young and tender plant for one older and more hardy, when tenderness is regarded as the cause of the failure, seems to us a very extraordinary cure for the disease. It does not alter the case that rolling is also recommended, for, if that operation is to be regarded as beneficial, the older plants can be as easily rolled as the younger, besides a greater degree of solidity preserved to the soil than when it has been loosened by harrowing. In so far as protection to the neck of the plant is concerned (and this seems to be all that is considered necessary,) it is evident that solidity cannot be maintained through winter, in any soil that contains more moisture than is essential for the purposes of vegetation; for every frost that penetrates the soil to the depth of one inch, must completely destroy the solidity which either the treading of sheep or rolling can effect. Besides, Mr Thorp seems to forget that the solidity imparted by the first of these means must be completely destroyed, for two or three inches upon the surface, by the subsequent operations of ploughing and harrowing in the seeds in the following spring.

It now remains for us to show that there are various causes which have all more or less influence in occasioning the failure of the clover plant, and to endeavour to point out the means by which the evil may be remedied.

When we ascertain the composition of any plant, we will find that the proportions of its organic and inorganic constituents are in many respects different from every other plant, however nearly allied it may be to them all, and that even the different parts of the same plant contain those same constituents in different

proportions. In so far as the inorganic constituents are concerned, there is no source from which they can be derived in sufficient abundance but the soil; and as these substances are found to exist in the soil in very unequal quantities, there is no doubt but that, while one kind of plant is withdrawing one substance in greater amount, another is appropriating another substance in a larger degree, and so it is with every crop. It is, therefore evident, that unless these substances are restored in quantities equal to what have been abstracted, the soil must in course of time be exhausted. It is also evident, that while some of these substances readily accumulate in sufficient abundance from the decomposition of matter which is continually taking place, others are very slowly restored, and some scarcely at all, unless when contained in the manure which is from time to time applied. It may be observed, that in the course of the ordinary operations of husbandry, some of the more soluble of these substances may be carried down by the rain into the soil, while in a pulverized state, in greater abundance than they are produced by natural causes, to a depth to which the roots do not extend. Under these circumstances, it is not to be wondered at that the soil should be sooner unfitted for the growth of some crops than for others; and especially for those crops which require a larger amount of those substances which, in the first instance, exist in the soil in more limited quantities, or which are more soluble and carried away by rain to a depth beyond the reach of their roots.* This is, perhaps, more the case with red clover than any other plant, which will be more apparent when we avail ourselves of the aid that chemistry affords. It tells us, in the first place, that 1000 lbs. of red clover, in the dried state, according to the analysis of Sprengel, contain the following proportions of inorganic matter:—

Potash,	19.95
Soda,	5.29
Lime,	27.80
Magnesia,	3.33
Alumina,	0.14
Silica,	3.61
Sulphuric acid.	4.47
Phosphoric acid,	6.57
Chlorine,	3.62
	74.78

From this analysis we learn the very large proportion of potash which red clover abstracts from the soil, when contrasted with the other crops with which it is generally associated in the course of a regular rotation.

* See Professor Johnston's Lectures on Agricultural Chemistry, p. 265.

Wheat contains in 1000 lbs. of the grain,	2.25	Straw 1000 lbs..........	2.45
Barley,	2.27	......	1.80
Oats,	1.50	......	8.70
Rye-grass hay,	...	......	8.81

If we allow that the straw is double the weight of the grain, then in 1000 lbs.

Of wheat there is only	.89	of potash.
— Barley,	2.13	......
— Oats,	6.30	......

Thus we see that 1000 lbs. of red clover requires nearly as much potash as is contained in twenty times the same amount of wheat, eight times the amount of barley, and three times the amount of oats, and twice of rye-grass, the very crops which are made to form part of the rotation along with it.*

Besides, potash is one of those substances which has a strong affinity for water, and is, on that account, very soluble in every state of combination in which it is found in the soil; hence its great liability, when the land is under cultivation, to be carried off by rain. This observation, however, applies more to the rain which falls in inland situations, or to those localities which are screened from the sea by some high mountain range; for there is good evidence to show that portions of the various saline substances contained in sea-water, and which contribute so much to the fertility of the soil, are often carried to considerable distances from the shore.† We may further observe, that it is owing to the still greater amount which the different green crops require of inorganic as well as of organic food, that a large application of manures is found to be necessary for their growth, in which case those substances cannot be said to be abstracted from the soil.

Although these remarks are made more particularly in reference to potash, as the substance which, with the exception of lime, enters more largely into the composition of clover than any other, and one which is more apt to be washed from the portions of the soil which is subjected to frequent cultivation, still they are applicable to other inorganic constituents, though many of them are less soluble, and exist often in much larger proportions than potash. This view of the case helps to explain why the red clover crop is less abundant on land which has been frequently cultivated, and why its failure is more perceptible on inland situations, than in those more exposed to the sea. But there

* Gypsum has been strongly recommended by Sir Humphry Davy and other writers on agriculture, as a valuable manure for red clover, but we have found that coal, peat, and wood-ashes—particularly the ashes of ash-wood—are much more efficacious. This is chiefly to be attributed to the potash which they contain.

† Liebig's Agricultural Chemistry, pp. 110, 138. And we believe that Dr Madden, when at Penicuik, had satisfactorily proved, by a series of observations there recently made, that the rain which falls between the sea and the Pentland hills, contains more saline substances than the rain which falls beyond that range.

are often causes of failure on soils which cannot be said to be deficient in any of the substances essential to the growth of this crop.

In the spring of 1841, we commenced a series of experiments, with the view of obtaining some information on this subject, and conceived that we were more likely to arrive at the truth, by beginning at the germination of the seed, and marking with care the progress which it made in the different stages of its growth. A piece of ground was selected adjoining the house, the soil consisting of a light fresh loam, and as much alike in character as one soil could be. Two rows of boards, eight inches broad, were placed edgeways, parallel with each other, at six feet apart in the ground. The earth was then put in and equalized between the boards till an inclined plane was formed by it, with a rise of one inch in the foot. The earth was thus level with the upper edge of the south board, and six inches below the upper edge of the north one. This inclined plane, though only six feet wide, was seventy feet in length. Sixty-eight gentle impressions were made upon the mould with the handle of a rake, after the plane was made as smooth and uniform as it could be. In those impressions, the same number of the different kinds of seeds most commonly used in agriculture were sown,* and more earth was then put in till it was level with the upper edge of the boards. The seed sown in this way, had little or no cover of earth at one end of the row, but the cover gradually increased, till it reached a depth of six inches at the other end. The boards enabled us to make this cover with great accuracy, so that at every part of the rows in which the seed germinated, there was an inch of additional covering of soil for every foot in length; so that by applying the foot-rule to the surface, we could ascertain at any time the depth of the seeds, and by assuming the half of the space in which the seeds germinated, that gave the proper depth of covering. The seeds were equally exempted from the risk of germination being prevented by too much cover, and at the same time from being lost, in case of dry weather, from having too little. We thus arrived at what may, with confidence, be regarded as the proper depth at which clover seed should be placed; and of six samples sown in this way, namely, English, French, American, Flemish, Juliers, Sucklings, the average, and therefore the proper depth, may be stated at one inch.

There is no doubt that seeds will germinate at a greater depth in a light gravelly or sandy soil than in a clayey one; but we consider the soil in which the experiments were made as equally removed from both these extremes, and, in this respect, as of a very fair average for an experiment of the kind.

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* For these, we were indebted to the kindness of Mr Thomas Kennedy, nursery and seedsman, Dumfries.

Having ascertained the depth, we proceeded, in the first week of June in the same year, to find out the proportion of seeds that might be expected to germinate in a given number of medium quality, such as are commonly sold in the shops. Out of 500 seeds sown in rows, at a distance of six inches in the row, 426 germinated, showing a deficiency of nearly 15 per cent. Out of one of Mr Lawson's best samples of 500 seeds sown, 475 germinated, showing a deficiency of only 5 per cent. This was not the only loss sustained at this stage of their growth, for before they had attained to what might be considered the rough leaf, there was scarcely a plant for every two seeds sown, showing a deficiency of at least 50 per cent. The insect which chiefly committed these depredations, was the same that so often destroys the turnip crop, although we cannot say that the slug had no share in them. In these experiments, it was not our object to destroy insects, but rather to learn the extent of the ravages which these enemies of agricultural plants are capable of committing. Whether they have been as destructive in former years, we have no means of knowing; but it it is not unlikely, that they, like every other species, may increase with the means of subsistence, and for whose support the extended cultivation of the turnip crop makes ample provision.

From what has been said on this part of the subject, it must be obvious, that even under the most favourable circumstances, much of the seed committed to the soil never attains maturity. When we think of the great disadvantages to which its seeds are exposed in field cultivation, the numberless chinks and crevices in a soil but moderately rough, in which they may be cast, it is not to be wondered at, that from this cause alone, the expectation of the cultivator should sometimes be disappointed. No clover seed should ever be sown until the soil intended to receive it is made as fine as light and strait-toothed harrows can make it to fill up the crevices, and only one strake should afterwards be given with them. There is another practice in many districts of Scotland, of eating down young grass with sheep and other stock, occasionally, from which much injury is sustained. It is but too common to see the grasses nipt as close to the surface as teeth can reach; and we have often observed clover, by this treatment, nipt over at the neck, which must, in every case where this happens, prove fatal to it; but although it may not have sustained injury to this extent, still it is stript of its leaves, and these, from the way in which they come out from the stem, and spread around it, are well adapted to afford the required protection to the stem and root. It is true that the leaves themselves are often laid prostrate by the severity of the frost, but this only causes them to fall around the neck and cling more closely to it. We would not be understood as condemning all pasturing

of young grass, for this often proves a great convenience for sheep; and we have invariably found it an unfailing antidote to inflammation of the bowels, or *braxy*—the disease to which young sheep are most subject. But we most decidedly condemn it when carried so far as to deprive the clover of all protection. Upon the same principle, we also regard the practice of mowing the grain crop with which the clover is sown, as very hurtful to the young grasses.

Having arrived at the knowledge of these facts, with regard to the depth of clover, and the depredations of insects, we began in the following spring another set of experiments, at the same time allowing all the clover plants of the previous year to remain in the ground, with the view of watching their future progress. We then set off a piece of ground, 10 feet square, and divided it into equal parts of a foot each; 400 clover seeds were then selected from Mr Lawson's best sample, one half of which were of the lighter yellow, and the other half the dark purple coloured variety, and the yellow was sown in the one half of the ground, and the purple in the other, to ascertain if there was any difference in their germination or durability in the ground; but in both respects there was scarcely any difference, the yellow, by a few plants, having the advantage in germination. Four of the selected seeds were planted in the centre of each foot of the ground previously laid off, with the intention of insuring one plant in each division, and as soon as the plants were considered out of danger from insects, only one was left in each space. Mostly all were in flower in September; but in this respect there was considerable difference; and all were cut down by the end of the month, that their treatment might be similar to what they would have received if grown with a crop. With the exception of six plants, they all survived the winter, and we believe they were those which were most advanced at the time of cutting, and after which they exhibited but little symptoms of throwing out fresh leaves. In this experiment no manure of any kind was applied, as the object was to obtain a knowledge of the durability of the red clover in the ground, when grown under the most favourable circumstances, in regard to space and new soil. The 94 plants which survived the winter, grew most luxuriantly in the summer of 1843, some of which brought to perfection fourteen stem-flowers, and none fewer than six, at the beginning of August, at which time one half were cut down, and the other half allowed to grow to the end of September, much about the time that the second crop attains its maturity, when we found that the plants which had thrown out the greatest number of flower-stems, when cut in August, were deficient in the number of their stems to the plants which were less vigorous at that time. After the September cutting, they began to throw

out leaves of a more sickly character than they had yet exhibited, but no flower stems. Not more than nine plants survived the winter; and the only indication of their having done so, was but a few sickly leaves, which made their appearance in April 1844, after which they died.

It appears from this experiment, and also from the duration of the plants of the first experiment in which we tried to find out the proper depth of cover, that all the different varieties of red clover generally cultivated in this country, whether the seed is from Holland, America, or any other quarter, are biennial, instead of perennial, as they are often represented to be. It is true that we often find plants of red clover in fields which have been sown out with it, years afterwards, but these have arisen from seeds which were placed under circumstances unfavourable to germination. As, for example, besides a sufficient depth of earth, stones are often pressed down with the roller upon the top of seeds, the air excluded, and germination for a time prevented. Next spring the stones are taken away on account of the hay-cutting, or they are turned over by sheep in winter, when this obstacle to germination is removed; but instead of in the first spring, this change in circumstances might take place at any future period, and the seed will spring up then, if it has not lost its vitality. Besides, there is a variety of red clover which is perennial, and indigenous to many soils of this country, more especially the drier parts of meadow land which have not been ploughed; but the seed of this variety is not commonly sold in the shops.

Much about this time, our attention was particularly directed to the improvements of Francis Maxwell, Esq. of Gribton, a gentleman in this neighbourhood, who, several years before, had commenced spade-trenching and thorough-draining on a very extensive scale. He had completed seven or eight fields of large extent, but of the worst quality on his estate, with thorough-draining and spade-trenching fifteen inches deep. We had almost constant opportunities of seeing the same fields for more than twenty years before these improvements were commenced. None of them were worth more than twelve shillings per acre, exclusive of the local advantage which they possessed, and others were of the very worst description of land in the country. They had at first been broken out of thin moor, with a cold and retentive tilly subsoil. The crops which they had yielded were very scanty, such as might be expected from such land. The clover never deserved the name of a crop. The fields had been limed in the first stage of their cultivation, and also slightly after being trenched. The rotation of crops taken after the improvements, was first, oats, then potatoes or turnips, then barley or oats, all of fair quality, and at same time sown out with rye-grass, and red and white clover. The healthiness of the red clover, on some of the fields,

was very evident after the grain crop was cut, and also in the rye-grass hay, but the after crop of the clover in October seemed one solid mass, and in several parts was completely lodged. These improvements on a large scale coincided with some experiments we had been making on a small one. That land which has been frequently cultivated, and which has become *clover-sick*, may be benefited by deepening the soil, and bringing a portion of those substances to the surface, of which it is either exhausted by the repeated cultivation of the clover, or which have been carried down by rain, is a fact every day receiving the additional testimony of those who have had recourse to subsoiling; and although the advantages of such operations are very evident on other crops, on none is it more so than red clover.

It may now be proper to show how the alkalies are restored to the soil, when rest or pasturage is substituted for cultivation. All soils consist of disintegrated rock, and whether these changes may have been, in the first instance, produced by some mighty cause, which produced more immediate results than we see in operation at the present time, agents are still constantly at work in the atmospheric changes of heat and cold, wet and dry, which are not less capable of accomplishing the disintegration of the hardest materials of which the globe is composed, and, in course of time, their decomposition also. By marking the operation of these agents, we learn the process by which the alkaline bases are made to form part of the soil, and the various saline combinations into which they are enabled to enter. Rocks of every formation contain some one or other of the alkalies, and often more than one, according to Liebig. Feldspar contains not less than 17 per cent of potash; albite 11 per cent of soda; zeolite 13 per cent of both alkalies taken together; granite, graywacke, porphyry, basalt, clay-slate, clinkstone, sandstone, lime, lava-loam, contain each their certain proportions, and the decomposition of any one of these rocks must always restore to the soil one or more of the alkalies. In the course of cultivation, there is always a constant breaking down of the materials of the soil, to which the *tear and wear* of the iron implements employed bear ample testimony; and although portions of the stones (fragments of the different rocks) of which they consist are in this way pulverized, still they supply no new food for the succeding crops until they have been decomposed, and rendered soluble—changes which will then be more speedily effected, and the alkalies restored in greater abundance than required for the purposes of pasturage. Carbon, azote, and the elements of water, which in different proportions unite to form so many of our most valuable animal and vegetable substances, and which are equally essential, are derived from other sources which can be more readily supplied to the soil; but until of late

years, when science began to lend her aid to agriculture, the application of the alkalies (with the exception of lime), as necessary constituents of every fruitful soil, formed no part of the practice of agriculture; and it is only when these substances are exhausted, that a soil is reduced to the sterile condition alluded to by Leibig, when he says, "that no quantity of manure could fertilise it for the production of certain crops;" and not, as he attributes it, to the injurious nature of the substances excreted from the roots.*

In these observations we have pointed out the causes to which the failure of the red clover crop is chiefly to be attributed, and shall now, in conclusion, shortly advert to what has been advanced on that subject, as well as on the remedies suggested.

1st, We see, then, that much seed is lost from falling into chinks and crevices; and that even in certain conditions of the soil, with the common harrow, so much cover may be given to the seed as to prevent its germination. This is more particularly the case when the soil is rough or damp, or of a heavy and impervious character. Clover seed can scarcely be sown in such descriptions of soil without more than one half of it receiving from two to three inches of cover, and, when rolled, it is entirely lost. It would be much better under such circumstances to sow the clover seed after the harrowing has been finished, and simply to roll afterwards, and in this way rather to risk the chances of its being destroyed by an over dry summer: the chances are at least three to one in its favour, the circumstances favourable to the growth of red clover being a dry or well pulverized soil, and not more than one inch of cover.

2d, It is also evident that a very large proportion of the plants, in the first stage of their growth, are liable to be destroyed by insects and slugs. At the present time we are aware of no remedy of general application for the evil but to sow less sparingly. In many districts the neglect of this precaution is too common an error. The quantity allowed in some, is from 4 to 6 lbs., in others from 6 to 10, and in some of the finer lands still more. Suppose, then, that in the first of these, 5 lbs. are given to the imperial acre of seed of average quality;† this is only one seed to every ten square inches, and if we deduct one half for the loss

* Although Liebig gives the countenance to the doctrine of radical excretion, which we have previously quoted, there is scarcely a chapter in his "Chemistry of Agriculture," in which he does not, in one shape or another, recognise the truth which we have here stated. "It must be admitted (he says) as a principle of agriculture, that these substances which have been removed from a soil, must be restored to it, but whether by means of excrement, ashes, or bones, is in a great measure a matter of indifference."

Professor Johnston, in his Lectures on Agricultural Chemistry, has established the same important truth upon a foundation from which it can never be removed.

† Supposing that there are 130 seeds in five grains, or 15,362 to the ounce.

sustained in germination and by insects, we have only one seed for every twenty square inches. We also found that 5 per cent was lost by frost, which will also make the distance still greater; and if we take the acre of Scotch measure, by which the soil is still calculated in many parts of this country, we shall have a space of nearly twenty-eight square inches around each plant.

3d, Before clover can be successfully cultivated on wet, or even damp land, it must be drained: first, because clover delights in a dry soil; and, secondly, when the frost expands the moist soil in contact with the neck of the plant, it is left bare after the thaw arrives, and is therefore more liable to be destroyed by the next frost.

4th, If clover is too closely cut down, it is left without the leaves, its natural protection, and if the frost is afterwards severe, is sure to be destroyed.

5thly, Mowing is objectionable to a certain extent, for the same reason. When the crop is cut with the sickle, a larger amount of stubble and foliage are left upon the ground for protection.

6th, These precautions are necessary to have a sufficient number of plants in the ground in spring, but it is clear that the future crop must also depend on the amount of the proper nourishment contained in the soil, and the facility with which it can be appropriated by the plants in every stage of their growth; for if stinted before the tillering commences, fewer stems will be thrown out, sometimes only two or three, and often when food is more plentiful, as many as a dozen, and all of them more luxuriant. From this cause, the crop may either be one-fourth the weight, or four times that amount, as was well illustrated in the case of Mr Maxwell of Gribton's crop, which had not received more than 3 lbs. of seed to the acre; but from the improvement which he had effected, nourishment of every kind was abundant, and the extraordinary manner in which the plants tillered in consequence furnishes us with a satisfactory explanation as to the uncommon weight of crop from so small a quantity of seed.

7th, It must also be evident, that the practice of eating down the second crop with sheep, must have a much greater tendency to maintain the soil in a favourable condition for the growth of clover, than when the practice of carrying it off the land to be consumed was more generally prevalent.

8th, We recommend with very much confidence, thorough-draining and trench-ploughing, as the most efficacious remedies which can be resorted to for restoring to its original fertility land which has become *clover-sick*.

REPORT OF EXPERIMENTS ON THE IMMEDIATE EFFECTS OF SPECIFIC MANURES.

By Mr Alex. James Main, Whitehill, Lasswade.

[Premium Fifteen Sovereigns.]

The farm on which the following experiments were made, rises about 450 feet above the level of the sea. It is situated from five to ten miles respectively from the Pentland range of hills on the one side, the Moorfoot range on another, and the Roman Camp on a third, and occupies the extreme point of an extensive coal district. The geological features, therefore, are those generally found in the coal formation, and consist of alternating beds of sandstone, shale, and coal; the sandstone greatly predominating. The farm is divided nearly in the centre by a rivulet or burn, from the bed of which the banks rise precipitately. On both sides of the burn, the coal formation obtains: the upper strata consist, generally, of boulder-clay of a very obdurate character, and varying in depth from a few feet to many yards; of large deposits of sand and gravel, sometimes mixed, but often pure; in many parts the sand is not less than twenty feet in depth; and of clay of a brown colour. The preponderance of one or other of these deposits, marks the character of either side of the burn. On the north-east side, the deposits of sand and gravel predominate, and immediately underlie the surface; hence, it is of a sandy character, loose, and easily wrought. On the south-west side, the clay deposits prevail, and the soil is consequently of a clayey nature,—not of a very obdurate clay, however, but one, in certain seasons, partaking sufficiently of the vexatious properties of that description of soil. On this side of the burn, sand is also found of the description, termed running or quick-sand; it is of limited depth, and betwixt it and the surface, a stratum of strong clay intervenes. This clay varies in character, in some parts pure red clay, easily worked with the spade; in other parts, a stone is found mixed with it, rendering it less easily wrought; while still a third part, presents a strong chattery clay. This is chiefly found in the rising ground of the field described in Tables B and C; and the nicely defined line, marking on the one side the flat surface with its pure deposit of red clay, on the other, the steep acclivity with its heterogenous subsoil, argues some violent subterranean outburst. The

general appearance of the surface is undulating; in some parts of the farm these undulations are to be ascribed chiefly to "sits" in the coal working, but in others, to natural depressions and elevations. The climate is variable, but healthy, and may be placed in a third-rate position, that is, being distant about ten miles from the sea, harvest is nearly three weeks later than in the neighbourhood of that element, and the intermediate distance gives an intermediate date to the harvest. From its relative position to the hills, the farm, and indeed the estate of which it forms a portion, is much affected by rains. Though, in general, we get our fair share of that aqueous blessing, we not unfrequently, in hot summers, are denied its refreshing showers, and, truth to tell, are sometimes saved from its drenching favours.

No doubt, from the abundant rains prevalent *throughout* last season, the crops have been more or less affected, and the effects of the several manures, in all probability, more or less injured; still, I think, their several real and relative values, as well as the advantages or disadvantages resulting from mixtures, have been so developed, that some idea may be formed of the estimate to be put upon them. The manures were all purchased from extensive and respectable dealers in these articles, and of the best quality I could obtain. The modes of their application are mentioned in the remarks on each table. I may however mention, that, in fixing on the *amount* to be applied, I took less note of *equal cost* than of *equal quantity*. I considered this latter principle the truest foundation on which to test, first, the real and relative value of each manure, and, secondly, to discover which individual or mixed application was most fraught with economical benefits to the farmer.

The money value of the straw and grain crops, as well as of potatoes and turnips, are estimated as nearly as possible at market prices, rather, I should say, below than above them.

Remarks on Table A.

The field on which these experiments were made, is a stiff clay, resting on a strongly retentive subsoil, of the description noticed in my prefatory remarks, as having a stone mixed with it. Previous to being drained, it was exceedingly wet, and though by no means a bad soil, it produced but sparingly. The draining has vastly improved both its intrinsic and productive qualities. The field rises with a steep ascent from the north-east, in the direction of the south-west, for about one-third of its length, the remaining two-thirds have a gentler acclivity in the same direction; the exposure, therefore, is north-east.

Application No. 8 early took the lead in appearance, and, so far as colour was concerned, maintained it to the end. No. 4, however, was not a whit inferior in promise of yield. Nos. 3, 7, 9, 10, though inferior to the two numbers named, presented no marked difference in appearance. Nos. 2 and 1 had nearly an equality. Nos. 5 and 6 were decidedly inferior. During their whole growth, these two latter numbers had a most unpromising appearance, and fully realised it.

The substances were applied broadcast on the 17th May. The weather at the time was damp, but not rainy. Though the latter promised its influence next day, I was disappointed; it cleared up, and continued dry for eight or ten days. Perhaps, on this account, and the lateness of making the application, the effects of the manures are so inferior.

This experiment, with the one on potatoes, was my first application, and I must confess it is too erratic in character to be of material value, or to lead to just conclusions. However, there can be no doubt of the superiority of some of the manures. Saltpetre refuse takes the first place in this respect. It had, it is true, one cwt. additional to most of the others, but I am not sure that it was materially benefited by the addition. Compared with nitrate of soda it is superior, not in yield, but in economical results; its cost gains for it this distinction. Guano is not equal to the saltpetre refuse; it is much inferior in produce, and though costing less by 16s. 6d. per acre, is also inferior in economic results. One additional remark I make on this experiment, to point out the good effects resulting from mixtures: applications Nos. 2, 5, and 6, are very poor in their results when individually applied, but combined, and with sulphate of soda added, the effect is reversed. The yield is not so large as that from nitrate of soda and saltpetre refuse, but it takes the third place in this respect, and the second, as to economic results: a decided proof of the value of mixtures. I may remark, in addition, that as a producer, sulphate of ammonia has, neither in this nor any other of my experiments, maintained the reputation it has acquired in other places. On the other hand, sulphate of soda has, from its inferior results in other recorded experiments, agreeably disappointed me: a proof that the success or failure of one manure in one place, is no guarantee that similar results will follow its application in another place. It also proves the necessity of widely extended experiments, conducted in localities and on soils as different from each other as possible.

Remarks on Table B.

The field on which the experiment in this Table was con-

ducted, is of a moderately heavy clay-soil, resting on a stiff, pure, red subsoil, easily workable. The field has two natural divisions—the one a rising ground, with a considerable acclivity towards the south-east, the other rather flat lying, extending about one hundred and fifty yards from the base of the rising ground in a north-west direction; having, lengthways, a slight inclination from south-west to north-east; consequently, with the latter exposure. In each of these divisions the subsoil is completely different. The flat portion is the one on which this experiment was made, and in soil and subsoil is of the descriptions above stated. Previous to being drained, the entire of this field was very wet; the portion of it in question, from its flat character, particularly so. Now, it is very superior, and of greatly increased value. This field will undergo the operation of subsoil-ploughing this winter.

The manures were all applied broadcast immediately after rain; rain immediately followed, and a corresponding effect was the consequence; the manures speedily developed themselves.

I have indicated as correctly as possible, the progress and appearances during the growth of the crops from the several applications, by the relative position of the numbers of each, in the proper column of the section for that purpose. In respect to richness of colour, nitrate of soda took an early lead, and maintained it to the end. The crop from the sulphate of soda came very nearly up to it, but never arrived at its richness and freshness of *green*. Many of the other substances, however, gave promise of a larger yield of straw. No. 3, sulphate of ammonia, was backward and unpromising during the whole season.

My object in this experiment was chiefly to compare the real and relative value of guano and prepared night-soil, in the individual and mixed applications. Of course the value of the other substances used could be ascertained at the same time. Guano, in the majority of the applications, has proved itself a good manure, and superior to night-soil. The latter, however, in this experiment, is not to be despised. In the individual application, guano produces more grain and straw, but is much surpassed by night-soil in the weight of grain. Calculating both at the same price of grain, guano is the most satisfactory in economical results. Of the mixtures, guano is superior in two, night-soil in one. In the latter case, the superiority over guano mixed with the same substances, is very considerable, whether as to produce of grain and straw, or in economical results; the mixture with guano, however, gives a slight advantage to the latter in weight. Another proof this of the value of mixtures, as in the case of both substances their productive powers and economical results can be made, by mixing them with other

substances, greatly to exceed the same effects from the single applications. For the substances most beneficial in mixture with guano and night-soil, see Nos. 9 and 10 of this Table. The real value of both these manures is good; in the relative value guano excels. Choosing the best mixtures with each of these substances, in real value both are again good, superior in this respect to themselves individually applied; in their relative value night-soil excels. These results are interesting, for while they testify to the value of mixing manures, they prove that, one manure inferior in real and relative value to another, when individually applied, can, by judicious mixtures, be made to surpass it, at all events in economical results. In the actual results, the produce from both mixtures are nearly equal. Of the other individual applications, saltpetre refuse is unquestionably the superior. This is in every respect a very satisfactory manure; it excels both in produce of straw and grain, and of all the applications is the best in economical results. It is deficient in weight to some of the others, though, to a certain extent, this may be accounted for from the laid state of the crop. Next in value is sulphate of soda. In produce of grain it is very nearly equal to saltpetre refuse, but in straw it is much inferior; and, also, it is slightly deficient in weight. Of the two substances, saltpetre refuse is superior in all the essentials, but from the fact that with nearly seven cwt. of straw less per acre, it is only deficient in grain to the extent of three bushels, I am inclined to set down sulphate of soda as a most excellent grain producer, and a manure in itself of real value. In combination with night-soil and animal charcoal, these two substances do not increase their value as either grain or straw producers, but they greatly augment their weight; in combination with guano and charcoal their weight is augmented, but they are greatly inferior to themselves, or in mixture with night-soil, in the produce of both straw and grain. In the individual applications, their relative value is greatly superior to any of the other substances. Of nitrate of soda and sulphate of ammonia I can say little in their praise, especially of the latter. Neither of these substances, individually applied, have succeeded, and therefore, taken alone, their real value is inferior; relatively, the former is superior to the latter. The effect changes when the two are combined with guano and animal charcoal. In straw and grain their produce is excellent, though deficient in weight. Combined with night-soil and animal charcoal, they surpass their individual produce, but do not equal their produce from the former mixture. These are most important facts, and no clearer proof can be afforded of the value of mixed manures. Individually applied, these manures may be called complete failures; combined, as in appli-

cation No. 9, they are most valuable, the mixture paying its own cost, and leaving a handsome profit. Of the other substances used in this experiment, I may state, that the sulphate of magnesia is not so valuable as either of the other sulphates, and that animal charcoal greatly surpasses gypsum. This I have found an invariable result; indeed, so greatly has gypsum failed, that I am much inclined to attribute its failure to some property in itself, if not detrimental to the plant, at least not suited to the soil of this locality.

Remarks on Table C.

This field is the same in which the last experiment was made, with this difference—the last experiment was made on the flat portion, this on the rising ground, of the field. Of the two portions, little difference is observable in the quality or depth of the soil; the former being, if any thing, deeper. The subsoil, however, quite varies. That, being a pure red clay, this what is locally termed "a chattery clay," very difficult to work; indeed, while being drained, it had to be wrought entirely with the pick, no portion of it being workable with the spade. This variety in the subsoil, influences, to a certain extent, the productive qualities of the soil; the low portion of the field being much more to be depended on, especially in regard to the clover crop. In the draining of this portion of the field, a good deal of under water was found; from some parts of it the flow was very abundant.

The manures were applied in the spring, broadcast, and after a few days of heavy rain. Rain very soon followed their application, and, in so far, every justice was done them.

The difference in the appearance and progress of the crop during growth, was so very small. that remarks on it are quite uncalled for. In promise of straw, however, Nos. 3, 4, and 5 were decidedly superior; No. 5 the best. I observed, during the growth of the wheat, that on *one side* of the ear several of the pickles were blank. The side *invariably* affected was that the most exposed to the weather, that is, to the south and north-west, and the west itself. Probably, the injury to the ear was occasioned from the severe storms which prevailed at the time the plant was in flower; thereby the flower would be destroyed, and a blank pickle must necessarily follow.

The substance most prominent in this experiment is prepared night-soil. In this experiment it has proved itself a most valuable manure. Compared with others, it is surpassed by saltpetre refuse and pigeon dung, in produce of straw, but it is unapproached by any as a producer of grain; in its economic results

it is most satisfactory. On the whole, its real value as a top-dressing is very high; equally so is its relative value. Next in value is saltpetre refuse. As a straw producer it surpasses all; in grain it is very respectable; in weight it is deficient; but on the whole it may be set down, in real and relative value, second. The third is pigeon dung. This substance, however, is not extensively available, and is only placed among the experiments for the sake of comparison, as from circumstances I was in a position to make use of nearly a ton of it. It is a valuable top-dressing, however, for wheat, and where it can be obtained the opportunity should not be lost. African guano has rather disappointed me; I certainly expected it would have paid its own cost. However, one consolation springs from this unfavourable result, namely, if guano fails, its loss, so far as wheat is concerned, will not be great. In real and relative value, guano occupies the lowest position among the individual applications. The same result follows its application in mixture with saltpetre refuse and gypsum, compared with night-soil mixed with the same substances. True, both are losing applications, but while the loss on the mixture containing night-soil amounts only to 2s., on the mixture containing guano it is £1, 2s. 6d.—a most tangible difference. Of the two mixtures, Nos. 6 and 7, No. 6 is the best. These mixtures lead to no very obvious results. Nitrate of soda was intended as their main feature, but from the erratic principle which guided the weights of the substances, no true deductions for or against it can be drawn. I am much inclined, however, to attribute the good effects of No. 6 to the presence of animal charcoal, and in some measure, also, to the good effects of sulphate of ammonia, combined with nitrate of soda. This last idea is favoured by the results obtained from some of the mixtures applied to the oat crop.

Remarks on Table D.

The soil of this field is a moderately strong clay, resting on a retentive subsoil; in some parts of the field a mixture of sand is found with the clay of the subsoil. The field is formed of two rising grounds, with a valley between; the one rises in the direction of north-west, and the other of south-east. The arena of this experiment occupies the rising ground to the north-west, consequently, that portion has a south-east exposure. Before being drained, the field was very wet, it is now quite the reverse. Since draining it, I have had two fair turnip crops, and most luxuriant oats and barley. The latter was the crop on which the experiments were made.

The applications were all made during rain, and spread broad-

cast. I applied only one cwt. in each application, for the following reasons:—1st, the field was in "excellent heart," and being sown out for permanent pasture, I was afraid of injuring the grass. 2d, I was anxious to ascertain what effect so small a quantity would produce.

Except in the case of No. 5, no appearance was presented by any of the applications calling for particular remark. No mistake could be made in respect of the position to be occupied by No. 5; it was decidedly the most inferior, and continued so to the last.

In this experiment saltpetre refuse again takes the lead among the individual applications, and is the first in real and relative value. Compared with night-soil it is superior in the produce of straw and grain, but is slightly deficient in weight. Night-soil, however, is here again a most valuable grain producer, though of the whole of the applications, with the exception of No. 5, it produces least straw. In the production of grain, compared to its produce of straw, none of the applications can compete with it. Guano is very much its inferior, and in fact, as a top-dressing to barley, is not to be highly appreciated. A curious result follows mixture No. 5. It is a decided failure, though containing at least two very valuable manures. This I am inclined to think is the result of the combination of guano and night-soil, without a corresponding amount of corrective substances. Of this more anon. A very valuable confirmation of the value of mixtures follows. No. 5 contains the three individual substances, used in combination; as a top-dressing the mixture fails. Nos. 6, 7, and 8 contain the same substances, with an additional one added to each of the three applications, and each has some trait of excellence. Nos 6 and 7 are good, both in grain and straw, No. 6 having the superiority; and No. 8 is good in straw, the grain crop losing nothing compared with No. 1. No. 8, however, is the best producer of weight. On the whole, in the mixture, animal charcoal is the most valuable; the economic results from the application containing it, being the most satisfactory. It is, however, deficient in weight. In the matter of weight, the whole of the applications, with the exception of No. 6, are nearly equal.

Remarks on Table E.

The soil of this field is a light loam, resting, for the most part, on a gravelly subsoil, and except a very small portion of it, which has been drained, is quite dry. The field is a flat lying one, with considerable depressions caused by "sits" in the coal workings. From being surrounded by woods on the west and north, the field has a south and east exposure.

The manures were applied to the drills previous to covering in the dung; they were spread by the hand as evenly as possible, and covered up as soon as sown. In the case of the two plots top-dressed, the substances were applied during rain, and immediately previous to the potatoes being furrowed up.

I have indicated, as accurately as possible, by the relative positions of the numbers, the progress and appearance during growth. I have only to remark that, soon after top-dressing Nos. 7 and 8, the crop from the latter took a vigorous lead, maintaining it to the end. No. 7 profited little in appearance by the top-dressing, and always continued the most unhealthy and unpromising of the whole.

In the simple mixtures in this experiment, guano takes the lead in applications Nos. 2 and 5. An important fact is deduceable from the results of these two applications, namely: that a less proportion of dung to a larger quantity of guano, is the most profitable way to combine these two substances. And in other experiments I have found this hold good. Night-soil is in this case inferior to guano, though on the whole profitable. In yield, night-soil is superior to pigeon dung, but from the cost of the latter, it surpasses the former in economic results. All these are fair manures, and worthy of attempted improvements. As a whole, mixture No. 6 is a good manure; but I will not attempt to draw conclusions from it, in consequence of its irregularity. No. 7, both before and after the top-dressing with guano, is a miserable failure. Compared with itself, however, after the top-dressing with guano, it is much improved, and greatly more than pays the extra outlay. No. 8 is a gaining application with the top-dressing, but it has other recommendations. It alone, of all the applications, produced a healthy crop; and it really was healthy, not a curled shaw appearing in the whole crop. It continued to grow vigorous and healthy long after the crops from the other manures were quite dead. This fact argues the presence of an essential ingredient in this mixture, and I am inclined to think that ingredient is the sulphuric acid. If so, it would be worth while to apply the substance more extensively. Nothing could exceed the beauty of the crop from it. Its yield is not very great, but I think that attributable to the fact that nearly one-fifth of this crop did not braird, occasioned, I think, by not diluting the acid, thereby rendering it destructive to the plant. From the idea I have entertained, that the healthy appearance of this crop is the result of the application of sulphuric acid, I have been convinced of the propriety of *steeping* potatoe seed. This idea I saw suggested by Professor Johnston, and my experience leads me to give it all due weight. I may add, that except in the application of the manure, the respective crops

were treated exactly in the same way; they were all planted with the same seed, and had all the same home manure. But the whole crop, with the exception of that from No. 8, was deeply affected by the "curl;" and from none of the applications but No. 8 was any improvement observable. No. 7 had the worst appearance of the whole, and I should say that if the mixture, without the top-dressing, had any effect at all, it was to propagate and strengthen that pernicious disease.

Remarks on Table F.

This field is composed of a light soil, resting, for about two-fifths of it, on a gravelly subsoil, and perfectly dry. The remaining fifth rests on a subsoil of wet sand, superincumbent on the boulder-clay of the coal formation. This part of the field has been drained. For the most part the field is a flat lying one; at the extreme end it declines gently to the north-west. It is exposed in every direction except the north-east, on which side it is sheltered by a wood.

The specific substances were applied with the dung in the drills, and covered up in the usual way.

The relative position of the numbers in the proper place indicate pretty accurately the progress, &c. of the crop, during growth. More particularly, I may mention, that both pigeon dung and night-soil were in all the lots inferior to guano, Nos. 2 and 3 of lot No. 2, having any approximation to it. Lot 1, farm-yard manure, kept its growth and colour longest, and in appearance had a decided preference. In promise of bulb, however, it was surpassed by nearly all the guano applications. No. 1 of lot 4 was decidenly superior to the whole field.

Before estimating the real and relative values of the applications, I beg to state that the crop mentioned in the Table was not the one intended to be experimented on. The first seed sown was of the Swedish variety; from some cause it failed; to this succeeded a sowing of Dale's hybrid, and it failed; the field was then sown with the crop reported on, white globe. This succession of failures may account for the smallness of the crop, and probably, too, for the limited results attending some of the applications. I attribute the failure of the two first sowings, in a great measure, to the seed; but it is possible it might result from its proximity to the specific manures, especially where the application was heavy. In this way, more particularly, do I account for the failure of the second sowing, as the same seed on the same and another field succeeded well.

My object in this experiment was twofold—first, To ascertain

in what proportion farm-yard manure and the specific manures should be applied to ensure the largest amount of economical results; and thus to determine the saving, in the former, which would result from the application; 2d, To determine the relative value of guano, compared with the other substances used. In the one object I have succeeded, in the other failed. I have succeeded in ascertaining that the best proportion in which to mix farm-yard manure and guano, is at the rate of fifteen tons of the former to three cwt. of the latter. This proportion secures the largest crop and the largest amount of pecuniary return, while a saving of one-half of home manure is secured—a most important fact, and one of great consequence to a farmer, where, from isolation of locality, or other causes, a full supply of home manure cannot be obtained. To this must be added the vast saving effected in carriage, where, from a deficiency of home manufacture, horse or cow manure must be driven from a distance. Nearly an equal economical result follows the application of ten tons of farm-yard manure, with four cwt. of guano. But as this is effected from the saving in cost, and not in increased produce, I would at all times prefer the former mixture; inasmuch that the soil will be more benefited by the larger application of home manure, as that it secures the largest yield in crop. With night-soil the most successful application, in respect of economical results, is from No. 2 of lot 5, where 10 tons of home manure are applied with 6 cwt. of the night-soil. However, the yield in bulb is very small, and, as a balance against the advantage gained by the application, it is, in my estimation, determinate of its value, namely, that the advantage gained by it is not a suficient inducement to continue its application. The same remarks apply to pigeon dung. The largest vegetative results from night-soil and pigeon dung are found in applications Nos. 2 and 3 of lot 2, where the proportions are 25 tons of dung to 1½ cwt. of each specific. So far as night-soil is concerned I would reject this application also; no increase is effected in bulb, and the saving of manure and the economic results present no inducement to continue its use. Still, by the addition of another substance to night-soil, it might equal guano in results. In my second object I have failed. I should have adhered strictly to my resolution to try the relative value of the specifics employed, by applying them weight for weight. I was induced to apply them in the proportion of 1½ cwt. of night-soil to 1 cwt. of guano; hence my failure. Notwithstanding, I am convinced that to bulbous crops guano is superior to night-soil, individually applied. In mixture, it will afterwards be seen that the latter can at all events equal the former.

Remarks on Table G.

This field has a light, in some parts approximating to a sandy, soil, and in general rests on a sand and gravel subsoil. A very small portion of the field lies flat, the remainder has a considerable declivity to the south-west, in which direction it is exposed. With the exception of some trifling wetness from under-water, the field is dry.

The specific manures in this experiment were sown broadcast over the drills after the dung was spread in them, and with the latter immediately covered. I consider this the best mode of applying specific manures. If any tendency to destroy the seed should be incipient in them, this *thin* mode of application renders their destroying powers abortive, nor does it in the least militate against their fructifying properties; on the contrary, it improves them. The soil more readily acts on them, and their wider distribution in the drill, enables the net-work roots of the plant to benefit by their presence more readily, and to better purpose, than if they were spread in body in the *bottom* of the drill.

In this experiment guano has still the advantage over night-soil applied to the turnip crop. Animal charcoal, as an auxiliary to guano, is superior, in a slight degree, to the nitrates, but with night-soil the latter is superior to the former. Sulphate of magnesia and gypsum, applied with both substances, fail to produce an equal amount of bulb to the other mixture. This inferior result I attribute to the presence of gypsum; in no case has this been beneficial in my locality. Perhaps the large quantity applied in this case may have been injurious, but in smaller quantities it has equally failed, and no alternative is left but to condemn it. Compared with farm-yard manure alone, all the applications, No. 7 excepted, have been successful in raising a larger weight of bulb; but the whole are advantageous in economical results. No. 2 is a most excellent manure, and certainly preferable to all the others. Night-soil in No. 3 is good, and decidedly the advantage resulting from this substance, in almost every application to every crop, whether it succeeds or fails, as compared with other substances, is such as entitles it to high consideration, and induces to resort to every means adequate to its improvement.

Remarks on Table H.

This field is the same with that mentioned in the preceding Table, and, therefore, no further remarks are necessary.

After dissolving the bones used in this experiment, the solu-

tion was spread in layers on common fire ashes, and the whole turned carefully over and mixed. I should mention that the other substances employed were all, in their respective proportions, put into the tank with the bones, and allowed to participate in the fermentation consequent on the application of the diluted acid. As no home manure was employed, the field was not ridged or drilled till after the application of the substances in broadcast, with shovels from a cart. It was then made into the usual drills, and the turnips sown.

Little distinction was observable on the crops of this experiment. No. 5 alone showed any superiority, but certainly this was very distinguishable; and it continued to maintain it till lifted.

My object in this experiment was to ascertain if bones alone, in considerable quantity, dissolved in sulphuric acid, or bones applied in less quantity, in conjunction with other substances, would raise a crop equal, or superior to farm-yard manure. The results prove an affirmative in three applications, and a negative in one. I have an idea, however, that all would have been affirmative had an additional quantity of sulphuric acid been given to the four quarters of bones. I did not think them, when applied, sufficiently dissolved, and, consequently, they were in a state not so easy of assimilation by the plant. It is interesting, however, to find that a less quantity of bones, dissolved in acid, and combined with one or more additional substances, will produce a superior result in vegetative and economical results than is produced by double or three times the quantity of dissolved bones applied alone. This I consider a most important result, and well worthy of attention. Thereby a great saving is effected in the first outlay, and a larger, or at least as large, a yield in bulbs produced. Mixture No. 5 is least in cost and highest in value. The results from this application are highly satisfactory, and not the less interesting. It demonstrates the fact that guano and night-soil, combined with dissolved bones, work well together. I have a theory on this subject which I may afterwards propound. Comparing mixtures Nos. 3 and 4, night-soil has a slight advantage over guano, both in bulbs and tops, and also in economic results; proving, I think, that in mixture at least, night-soil may prove a worthy substitute for guano. And the fact that such can be found, may enable us with greater fortitude to contemplate the possibility of deprivation in the latter article. Mixture No. 5 proves, that two ammoniacal excrements, or other similar substances, when combined with a sufficiency of absorbent power, are superior to one only with animal charcoal in alliance. Dissolved bones applied alone have failed to equal the produce from home manure. From the less cost, however, the economic results are greater, and on the

whole, could no advance in produce be made nearer to farm-yard manure than is done in this application, the inducement to continue to use it would still be great. I have already said, that had the bones been more dissolved, a different result might have followed. I am convinced that this would have been the case; another year's experiments will prove it. I could have wished to try the effects of dissolved bones in combination with farm-yard manure, but neither time nor extent of ground allowed me to attempt the experiment. But from the experience I have this year had of dissolved bones applied alone, I am convinced such an application would succeed well.

General Remarks.

On reviewing the results obtained from the experiments recorded in the succeeding Tables, some important facts present themselves, well worthy of a more particular description. This I shall proceed to give as succinctly as possible. And, first, I would remark the fact, proved in the Tables, that one manure may be successful in one locality and not in another, and *vice versa.*

Sulphate of soda has proved itself, on this farm, a valuable top-dressing on oats; *sulphate of ammonia* the reverse. In other experiments on the same crop, conducted in other places, and reported in the Transactions of the Highland and Agricultural Society, the effects of the two substances were completely reversed. Sulphate of ammonia was the successful, sulphate of soda the unsuccessful application; I speak here of the substances in the individual application; in mixture, both are successful, and in varying degrees. On grass, the two succeed well *together*, in conjunction with common salt and pigeon dung; on oats, the most successful mixture with sulphate of ammonia, is guano, nitra of soda, and animal charcoal; and sulphate of soda succeeds best with night-soil, saltpetre refuse, and animal charcoal; on wheat, sulphate of ammonia succeeds well with nitrate of soda, applied with which substance, sulphate of soda fails; with the former, however, annimal charcoal was conjoined, with the latter it was not, and hence, probably, the success of the one and the failure of the other; on the potato crop, sulphate of soda succeeds, while sulphate of ammonia fails; the experiments in this case, however, are destitute of authority, from their erratic character;—on the whole, both substances are good in mixture. The facts connected with these substances, are demonstrative of the good results attending widely extended experiments; and from them also the lesson may be learned that, before largely using any manure, it ought to be carefully experimented on.

Saltpetre refuse has proved itself a most excellent top-dressing, both in the individual and mixed applications. Nor is it destitute of merit when applied with other substances as a manure to root crops; on all, it has exercised a most beneficial influence. As a grain producer, its value is great in respect of quantity, but it is inferior as regards quality. And in respect of grain, it is surpassed in the wheat crop by night-soil; besides that, comparing its produce in straw with its produce in grain, and both with the produce obtained from other specifics, it fails in producing a quantity of the latter corresponding with the amount of the former. In mixture, however, this failing is corrected, though the amount of produce in grain does not equal, in every case, its own produce, individually applied; as a set off to this, it is improved in quality. On the whole, this is a valuable manure.

My experiments in *night-soil*, are most satisfactory, and fully justify the conclusion, that it is a good manure. Probably in other experiments undertaken this year, the effects of this manure will be sufficiently brought out; if so, then a just appreciation of its value may be formed; if not, I submit that, from the good effects of it recorded in my experiments, its merits demand a more extended inquiry. I am aware that in England this manure has been long used and appreciated, but it is of very recent introduction into Scotland; and the merit of being the first to introduce it, so far as I am aware, belongs to Messrs Mack and Rutherford of Leith. The facts, however, are conclusive, and night-soil, if judiciously prepared will, I am convinced, attain to as much celebrity as guano. Every effort should be made to secure it in abundance; particularly, it should be impressed upon the authorities of cities and large towns, the desirableness and propriety of attending to its collection. This done, not only would a great national good be secured, but a large increase of revenue would result to the cities and towns themselves. Glancing at its effects, it is found to be rich in the production of grain, both in quantity and quality. As a producer of straw, it is inferior to many of the other applications; but, on the other hand, its economical results are superior. In mixture, its value is considerably enhanced, nor are its essential qualities diminished; its production of grain in the case of oats, is greatly increased, its quality little inferior; and its produce in straw, though still inferior to other substances, is largely augmented. In wheat, these remarks, in respect to mixtures with this substance, do not hold good. The produce, mixed with saltpetre refuse and gypsum, is inferior to that from its individual application. I attribute this, however, in a great measure to the presence of gypsum. That substance has not at all answered my expectations in any of my

experiments. And, again, this failure is the result of only one application in mixture, and therefore does not afford sufficient data for a decision. But, be that as it may, the fact that it is, in every essential particular, a most valuable top-dressing for wheat, is unquestionable. Compared with guano, night-soil has not been so successful in its application to root crops, nor on the whole has it entirely failed; a sufficient guarantee, that in respect to these crops, it is an improvable manure. This latter conclusion is strengthened by the fact that, allied to other substances, and applied to the turnip crop mentioned in Tables G and H, it in the one surpasses farm-yard manure in two applications, and nearly equals it in a third; and in the other Table, while it surpasses farm manure, it also excels the produce from guano itself—the mixtures with both substances being equal in kind and quantity. For the mixtures most beneficial in combination with night-soil, I must refer to the Tables, merely remarking, that in the instance of its surpassing guano applied to the turnip crop, it was in alliance with dissolved bones and animal charcoal.

Guano, as compared with night-soil, is inferior in the grain, and superior in the root crops. Its merits and demerits, however, are so well known, that I need not enter on their detail. This far, however, I may remark, that in case of the privation of this article, we have in the case of grain crops, equally good substitutes in saltpetre refuse and night-soil; and in respect of root crops, I have no doubt that bones and night-soil will be made to equal it. Referring to Table D, a curious effect is found to follow: in the first place, guano, saltpetre, and night-soil in combination, and in the next, the same substances with another added. The mixture of the three substances is a complete failure; with the addition of another substance, however, in each of three applications they succeed. In the first of these three applications, animal charcoal is added, in the second, sulphate of magnesia, in the third, nitrate of soda. The first is superior in straw and grain, but inferior to the other two in weight of grain; the second is superior to the third in grain, but inferior in straw and weight of grain; and the third is inferior to both the others in grain, but again surpasses both in weight. All, however, are very superior to the three substances in combination, and applied without the addition. The cause of the failure in the application of the three substances, I cannot sufficiently explain: that it is to be attributed to the combination of guano and night-soil, is not strictly consistent with the effects of the two combined in other experiments, and yet the fact, that the addition of another substance is sufficient to obviate the bad effects of the mixtures, seems to point in that direction. Probably, therefore, the fact may be, that two ammoniacal excrements operate injuriously on

each other, and that they require an amount of corrective power, equal on the one hand to saltpetre refuse and sulphate of magnesia, animal charcoal and saltpetre refuse, or nitrate of soda and saltpetre refuse, and on the other, to one quarter of bones dissolved in sulphuric acid. I take the facts as I find them, and these demonstrate that guano and night-soil do not operate well together, except when an equivalent amount of corrective power is applied along with them, or, which is to the same purpose, that these substances, equally divided, of which the two named are a portion, do not produce beneficial effects. I do not hazard an opinion in elucidation of this subject, my chemical knowledge being insufficient for the purpose; but the fact is interesting, at least to myself, and may be so to others more experienced, if it do not come under that class of facts which derive their interest solely from the ignorance of their discoverer. This conclusion, however, is clear, that guano and night-soil mixed, and in combination with other substances, is an excellent top-dressing for barley, and I have no doubt, equally so for other grain crops; and that the two substances mixed, and applied to turnips, with bones dissolved in sulphuric acid, effects a vast saving in the first cost, secures a larger crop, and is more satisfactory in economical results than a much larger quantity of dissolved bones applied alone.

Nitrate of soda individually applied, has not produced equally favourable results in this locality as in others. Probably its high price may have assisted in producing this unfavourable result, as certainly the appearance of the crop, when growing, did not indicate any failure in the manure itself. In mixture, it has been of great utility, and, no doubt, is worthy of considerable attention.

The experiment recorded in Table F, is an interesting proof of the fact, that *farm manure*, combined with guano, affords the largest amount of vegetative and economical results, when applied in the proportion of fifteen carts-load of the former to three cwt. of the latter. It would be interesting and instructive to enlarge on this experiment, and by the application of various quantities of guano, respectively applied to ten, fifteen, twenty, and twenty-five tons or cubic yards of farm manure, ascertain correctly, and beyond possibility of doubt, at what rate applied these manures would be most productive. The same remarks apply to the experiment on potatoes. Night-soil might also be conjoined in the experiment by itself, and with other substances, and the results might ellucidate facts of some importance.

I attach some importance to the experiment with *bones* on the turnip crop, exhibited in Table H. Bones, as a manure, is a most important article in agricultural economy, and they are most deservedly so. No experiment, therefore, tending to enlighten as

to their improvement, can be unimportant, especially if from their improvement they can be economised. Dissolving bones in sulphuric acid, has tended greatly to advance this great object, namely, the improvement and economy of bones as a manure. The facts, however, elicited by these experiments, tend to prove it still further possible to economise and improve them. A reference to table H will clearly illustrate the fact. I leave to persons more versed in chemical lore than myself to illustrate this point; but this I observe, that the larger the amount of the ammoniacal substance introduced into the mixture, the greater is the saving in bones, and in proportion is the crop increased.

Of the effects of *mixed manures* there can be no doubt. In every experiment undertaken to illustrate the properties of the specific manures, the results from mixtures bear a prominent part. In those I have undertaken, this remark also holds good; and there can be no question, but that in this way, the large proportion of our foreign manures should be used. No doubt, some trouble may be necessary to discover the best mixtures, but this done, the results will more than repay the cost. In the absence of mixtures, many of our best manures, at least our best used in this way, are lost sight of, and thereby we deny ourselves the benefit to be derived from their use. Nor, because a manure fails as an individual application, is it a reason for arguing its failure in mixture. This fact is distinctly proved in the succeeding Tables. Nor is this all, our best individual applications can be improved by combination, either applied to grain or root crops. Have we an individual substance excelling in the produce of straw, by a judicious mixture of this substance with one or more substances excelling in the produce of grain and in the weight of it, the properties of all may be improved, and the farmer more amply remunerated than by adhereing to any individual substance. A word of practical improvement. Not mine alone, but many other experiments have clearly elucidated most important facts; these should be promptly acted on. Much good is lost by inactivity in the application of truths derived from careful experiment. This should not be; for though some labour, and possibly experience, may be necessary to demonstrate their practical usefulness, the public and private interests to be subserved should, at all times, be a sufficient stimulus to the prosecution of inquiry. Let farmers collate and reduce to practice the facts to be gleaned from experiments already recorded, and they will reap benefit in their own profit, and promote the national good.

Conclusions.

1st, Every description of crop requires an ingredient essential

to its production, and without it such crop cannot be raised in perfection.

2d, If a soil does not contain in itself what is essential to the growth of the plant upon it, it must be supplied through the medium of one or other of the specific manures.

3d, The essential substance necessary to be added to the soil, may be discovered by consulting the nature and properities of the plant to be raised

4th, Nitrate and ammoniacal substances excel in the production of straw, grass, or potatoes, and turnip tops, without an equivalent production of grain or bulbs; so these substances should not be applied alone, but in combination with others containing phosphates. This is illustrated by the fact that saltpetre refuse and nitrate of soda, applied with guano or prepared night-soil and animal charcoal, improve their individual production, either in quantity or weight, or in both.

5th, Salts which are sulphates produce grain in larger proportions to their straw, than other salts which are nitrate or ammoniacal.

6th, Bone manure, though dissolved in sulphuric acid, may be greatly enhanced in value by the addition of ammôniacal substances; hence, it is inferred, that substances capable of imparting additional luxuriance to the foliage of plants, largely administer to their necessities, and, combined with phosphates, are highly advantageous.

7th, Sulphuric acid is eminently beneficial to the potato crop, and, in the experiment on that crop recorded in the Tables, has proved itself a preventative of the disease called "curl," having produced a healthy crop, when, from the same seed, and otherwise treated in the same manner, the other plants of the field were much infected with that disease.

I am aware that some of these conclusions are mere repetitions of ascertained facts, but truth is never injured by repetition. Perhaps I should have added to the list of my conclusions this one, that farm manure and guano, combined in the proportion of 15 tons of the former to 3 cwt. of the latter, is the proportion in which I have found these substances to succeed best; and as regards farm manure and night-soil, the best proportion is, 25 tons of the former to 1½ cwt. of the latter. This last result, however, may be greatly improved upon, and therefore should not be taken as a just criterion, either for the purpose of estimating the value of the night-soil, or determining the best mode of applying it.

TABLE A,

Exhibiting the immediate results of the application of Special Manures, top-dressed, upon sown Grasses. Manures applied 17th May. Hay cut 18th July. Weighed 30th August 1845. Calculations made per imperial acre. Hay estimated by the cwt. Special Manures by the cwt. Hay valued at £4 per ton.

No.	Substances employed.	Quantity of special manures.	Cost of ditto per cwt.	Cost of ditto per acre.	Total cost of ditto per acre.	EFFECTS OF SPECIAL MANURES. Produce of hay per acre.	Value of the hay crop.	ECONOMICAL RESULTS OF SPECIAL MANURES. Excess of produce in hay.	Value of excess.	Loss in hay.	Value of loss.	Gain from application.	Loss from application.
		cwts. lbs.	L. s. d.	L. s. d.	L. s. d.	cwts. lbs.	L. s. d.	cwts. lbs.	L. s. d.	cwts. lbs.	L. s. d.	L. s. d.	L. s. d.
1	Nothing	... ...	... ...	... ...	... ...	19 70	3 18 6	... ...	... ...	... ...	... ...	... ...	... ...
2	Sulphate of Ammonia	1 56	1 1 0	1 11 6	1 11 6	18 28	3 12 11	... ...	... ...	1 44	0 5 7	... ...	1 17 1
3	African Guano	2 0	0 6 9	0 13 6	0 13 6	22 50	4 9 9½	2 84	0 11 3½	... ...	... ...	... ...	0 2 2¾
4	Saltpetre	3 0	0 10 0	1 10 0	1 10 0	28 50	5 13 9½	8 84	1 15 3¼	... ...	... ...	0 5 3¼	... ...
5	Common Salt	3 0	0 3 4	0 10 0	0 10 0	17 91	3 11 3	... ...	... ...	1 79	0 7 3	... ...	0 17 3
6	Pigeon Dung	2 0	0 3 0	0 6 0	0 6 0	17 59	3 10 1½	... ...	... ...	2 11	0 8 4¾	... ...	0 11 4¾
7	African Guano	0 56	0 6 9	0 3 4½	1 18 4½	21 36	4 5 3½	1 66	0 6 9½	... ...	... ...	... ...	0 14 2¼
	Sulphate of Ammonia	1 0	1 1 0	1 1 0									
	Nitrate of Soda	0 56	1 1 0	0 10 6									
	Gypsum	1 0	0 3 6	0 3 6									
8	Nitrate of Soda	2 0	1 1 0	2 2 0	2 2 0	28 101	5 15 7¼	9 31	1 17 1¼	... ...	... ...	... ...	0 4 10¾
9	Pigeon Dung	1 0	0 3 0	0 3 0	1 0 8	24 46	4 17 7½	4 76	0 19 1½	... ...	... ...	... ...	0 1 6¾
	Common Salt	0 56	0 3 4	0 1 8									
	Sulphate of Soda	1 0	0 5 0	0 5 6									
	Sulphate of Ammonia	0 56	1 1 0	0 10 6									
10	Night-soil	1 0	0 5 0	0 5 0	0 11 3	22 3	4 8 1½	2 33	0 9 7½	... ...	... ...	... ...	7¾
	Saltpetre	0 56	0 10 0	0 5 0									
	Animal Charcoal	1 0	0 2 6	0 2 6									
	Gypsum	0 56	0 3 6	0 1 9									

TABLE B,

Exhibiting the immediate results of the application of Special Manures top-dressed upon Oats. Manures applied 26th May. Oats cut 1st October. Thrashed and weighed 16th October 1845. Calculations made per imperial acre. Grain estimated by the quarter. Straw by the cwt. Special Manures by the cwt. Oats valued at 21s per quarter. Straw at 2s. per cwt.

						VEGETATIVE EFFECTS OF SPECIAL MANURES.						ECONOMICAL RESULTS FROM THE APPLICATION OF SPECIAL MANURES.					
No.	Substances employed.	Quantity of specific man.	Cost of ditto per cwt.	Cost of ditto per acre.	Total cost of ditto per acre	Produce of grain per acre.	Produ. of strw. per acre.	Weight of grain per bushel.	Value of grain crop.	Value of straw crop.	Gross value of crop per acre.	Excess of produce in grain.	Excess of produce in straw.	Value of excess in grain.	Value of excess in straw.	Gain from application.	Loss from application.
		cwt. lb	L. s. d.	L. s. d.	L. s. d.	qr. bu. pk.	cwt. lb.	lbs. oz.	L. s. d.	L. s. d.	L. s d	qr bu. pk	cwt. lb.	L. s. d	L. s. d	L s. d	L. s. d.
1	Nothing	... ...	... ...	... ...	... ...	6 5 0	29 64	40 0	5 19 1½	2 19 1½	9 18 3	... ...	... ...	... ...	... ...	... ...	... ...
2	Nitrate of Soda	2 0	1 1 0	2 2 0	2 2 0	7 3 3	42 0	38 3	7 16 9¾	4 4 0	12 0 9¼	0 6 3	12 36	0 17 8¼	1 4 7½	0 0 3¼	... ...
3	Sulphate of Ammonia	2 0	1 1 0	2 2 0	2 2 0	7 0 2	32 6	40 0	7 8 3¾	3 4 1½	10 12 4¾	0 3 2	2 42	0 9 2	0 4 9	... ...	1 8 1
4	Saltpetre refuse	2 0	0 10 0	1 0 0	1 0 0	8 4 2	47 89	37 3	8 19 9¾	4 15 7	13 15 4¼	1 7 2	18 25	2 0 8	1 16 5½	2 17 1½	... ...
5	Sulphate of Soda	2 0	0 5 6	0 11 0	0 11 0	8 3 3	41 0	37 0	8 17 9¾	4 2 0	12 19 9¼	1 6 3	11 36	1 18 8¼	1 2 7½	2 10 3¾	... ...
6	Night-soil, prepared.	2 0	0 5 0	0 10 0	0 10 0	7 3 2	40 0	39 0	7 16 2	4 0 0	11 16 2	0 6 2	10 36	0 17 1½	1 0 7½	1 7 8	... ...
7	Guano, African	2 0	0 6 9	0 13 6	0 13 6	7 7 0	42 66	37 9	8 5 4½	4 5 2	12 10 6½	1 2 0	13 2	1 6 3	1 6 0¼	1 18 9¼	... ...
8	Night-soil	0 56	0 5 0	0 2 6	1 6 0	7 7 0	41 19	38 10	8 5 4½	4 2 4	12 7 8½	1 2 0	11 55	1 6 3	1 2 11¾	1 3 2¾	... ...
	Nitrate of Soda	0 56	1 1 0	0 10 0													
	Sulphate of Ammonia	0 56	1 1 0	0 10 6													
	Animal Charcoal	1 0	0 2 6	0 2 6													
9	Guano	0 56	0 6 9	0 3 4½	1 6 10½	8 3 1	45 38	37 11	8 16 6¼	4 10 8	13 7 2¼	1 6 1	15 74	1 17 4¼	1 11 3¾	2 1 10	... ...
	Nitrate of Soda	0 56	1 1 0	0 10 6													
	Sulphate of Ammonia	0 56	1 1 0	0 10 6													
	Animal Charcoal	1 0	0 2 6	0 2 6													
10	Night-soil	0 56	0 5 0	0 2 6	0 12 9	8 3 1	44 1	38 3	8 16 6¼	4 8 0	13 4 6¼	1 6 1	14 37	1 17 4¼	1 8 7¾	2 13 3¼	... ...
	Sulphate of Soda	0 56	0 5 6	0 2 9													
	Saltpetre refuse	0 56	0 10 0	0 5 0													
	Animal Charcoal	1 0	0 2 6	0 2 6													
11	Guano	0 56	0 6 9	0 3 4½	0 13 7½	7 5 1	40 78	39 0	8 0 9¼	4 1 4½	12 2 1¾	1 0 1	11 14	1 1 7¾	1 2 3	1 10 3¼	... ...
	Sulphate of Soda	0 56	0 5 6	0 2 9													
	Saltpetre refuse	0 56	0 10 0	0 5 0													
	Animal Charcoal	1 0	0 2 6	0 2 6													
12	Guano	0 56	0 6 9	0 3 4½	0 18 10	7 2 1	38 63	40 0	7 12 10½	3 17 1	11 9 11½	0 5 1	6 99	0 13 9¼	0 17 9	0 12 8¼	... ...
	Sulphate of Magnesia	0 56	0 12 0	0 6 0													
	Saltpetre refuse	0 56	0 10 0	0 5 0													
	Animal Charcoal	0 84	0 2 6	0 1 10½													
	Gypsum	0 84	0 3 6	0 2 7½													
13	Night-soil	0 56	0 5 0	0 2 6	0 18 0	6 7 3	34 61	39 0	7 6 4	3 9 1	10 15 5	0 2 3	4 97	0 7 2¼	0 9 8¾	... ...	0 1 1
	Sulphate of Magnesia	0 56	0 12 0	0 6 0													
	Saltpetre refuse	0 56	0 10 0	0 5 0													
	Animal Charcoal	0 84	0 2 6	0 1 10½													
	Gypsum	0 84	0 3 6	0 2 7½													

TABLE C,

Exhibiting the immediate results of the application of Special Manures top-dressed upon Wheat. The field manured with rape-dust sown broad-cast with Wheat, 27th September 1844. Special Manures applied 20th May 1845. Wheat cut 24th September. Thrashed and weighed 11th October 1845. Calculations made per imperial acre. Grain estimated by the quarter. Straw by the cwt. Special manures by the cwt. Wheat valued at 50s. per quarter. Straw at 2s. per cwt.

										VEGETATIVE EFFECTS OF SPECIAL MANURES.						ECONOMICAL RESULTS FROM THE APPLICATION OF SPECIAL MANURES.									
No.	Substances Employed.	Quantity of Rape-dust per acre.	Cost of ditto per ton.	Cost of ditto per acre.	Quantity of Specific Manures.	Cost of ditto per cwt.	Cost of ditto per acre.	Total cost of ditto per acre.	Cost per acre of both Rape-dust and Specific Manures.	Produce of grain per acre.	Produce of straw per acre.	Weight of grain per bushel.	Value of grain crop.	Value of straw crop.	Gross value of crop per acre.	Excess of produce in grain.	Excess of produce in straw.	Value of Excess in grain.	Value of Excess in straw.	Loss of grain.	Loss of straw.	Value of loss in Grain.	Value of loss in straw.	Gain from application.	Loss from application.
		cw. lb.	L. s.	L. s.	cw. lb.	s. d.	s. d.	s. d.	L. s. d.	q. b. p.	cw. lb.	lb. oz.	L. s. d.	L. s. d.	L. s. d.	q. b. p.	cw. lb.	L. s. d.	L. s. d.	b. p.	cw. lb.	s. d.	s. d.	L. s. d.	L. s. d.
1	Nothing.........	18 0	5 0	3 5	... ...	... ...	... ...	... ...	3 5 0	4 4 3	48 88	54 0	11 9 8¼	4 17 5¾	16 7 2	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...
2	Guano, African	18 0	5 0	3 5	2 0	6 9	13 6	13 6	3 18 6	4 6 0	43 74	53 0	11 17 6	4 7 8¾	18 4 9¾	0 1 1	... ...	0 7 9¾	... ...	... ...	5 9	... ...	10 2	... ...	0 15 10¼
3	Pigeon Dung...	18 0	5 0	3 5	2 0	3 0	6 0	6 0	3 11 0	5 1 3	56 88	58 0	13 0 11¼	5 13 0¾	18 14 6	0 5 0	8 5	1 11 3	0 16 1	... ...	... ...	... ...	... ...	2 1 4	... ...
4	Night-soil.........	18 0	5 0	3 5	2 0	5 0	10 0	10 0	3 15 0	6 0 0	55 9	62 10	15 0 0	5 10 1½	20 10 1½	1 3 1	6 38	3 10 3¾	0 12 8	... ...	... ...	... ...	... ...	3 12 11¾	... ...
5	Saltpetre refuse	18 0	5 0	3 5	2 0	10 0	20 0	20 0	4 5 0	5 3 3	68 99	50 0	13 13 5¼	6 7 9	20 1 2¼	0 7 0	15 16	2 8 9	1 10 8¼	... ...	... ...	... ...	... ...	2 14 0¼	... ...
6	Nitrate of Soda	... ...	... ...	... ...	0 42	21 0	7 10½																		
	Sulph. of Amm.	... ...	... ...	... ...	0 28	21 0	5 3																		
	Sulph. of Mag..	... ...	... ...	... ...	0 42	12 0	4 6	20 7½	4 5 7½	5 1 1½	51 12	52 0	12 13 7	5 2 2	18 0 0	0 4 2½	2 50	1 8 10¼	0 4 8¼	... ...	... ...	... ...	... ...	0 12 11½	... ...
	Gypsum.........	... ...	... ...	... ...	0 56	3 6	1 9																		
	Animal Charco.	18 0	5 0	3 5	0 56	2 6	1 3																		
7	Nitrate of Soda	... ...	... ...	... ...	0 28	21 0	5 3																		
	Sulph. of Mag..	... ...	... ...	... ...	0 28	12 0	3 0	14 6	3 19 6	4 4 0	46 68	53 0	11 5 0	4 13 2½	15 18 2½	... ...	... ...	... ...	... ...	0 3	2 15	4 8¼	4 3¾	... ...	1 8 0
	Sulph. of Soda.	... ...	... ...	... ...	0 56	5 6	2 9																		
	Gypsum.........	13 0	5 0	3 5	1 0	3 6	3 6																		
8	Guano.........	... ...	... ...	... ...	1 0	6 9	6 9																		
	Saltpetre	... ...	... ...	... ...	0 56	10 0	5 0	18 6	3 18 6	4 4 0	46 68	58 0	11 5 0	4 13 2½	15 18 2½	... ...	... ...	... ...	... ...	0 3	2 15	4 8½	4 3¾	... ...	1 2 0
	Gypsum.........	18 0	5 0	3 5	0 56	3 6	1 9																		
9	Night-soil.........	... ...	... ...	... ...	1 0	5 0	5 0																		
	Saltpetre	... ...	... ...	... ...	0 56	10 0	5 0	11 9	3 16 9	4 5 1	52 6	54 0	11 12 9¾	5 4 1¼	16 16 11	0 0 2	8 44	0 8 1½	0 6 7½	... ...	... ...	... ...	... ...	... ...	0 2 0
	Gypsum.........	18 0	5 0	3 5	0 56	3 6	1 9																		

Table D,

Exhibiting the immediate results of the application of Special Manures, top-dressed upon Barley crop. Manures applied 27th May. Barley cut 20th September. Thrashed and weighed 15th October 1845. Calculations made per imperial acre. Grain estimated by the quarter. Straw by the cwt. Special manures by the cwt. Barley valued at 28s. per quarter. Straw at 2s. per cwt.

No.	Substances Employed.	Quantity of Special Manures.	Cost of ditto per cwt.	Cost of ditto per acre.	Total cost of ditto per acre.	EFFECTS OF SPECIAL MANURES. Produce of grain per acre.	Produce of straw per acre.	Weight of grain per bushel.	Value of grain crop.	Value of straw crop.	Gross value of crop per acre.	ECONOMICAL RESULTS FROM THE APPLICATION OF SPECIAL MANURES. Excess of produce in grain.	Excess of produce in straw.	Value of excess in grain.	Value of excess in straw.	Loss in grain.	Loss in straw.	Value of loss in grain.	Value of loss in straw.	Gain from application.	Loss from application.
		cwt. lb.	s. d.	s. d.	L. s. d.	qr. bu. pk.	cwt. lb.	lbs. oz.	L. s. d.	L. s. d.	L. s. d.	bu. pk.	cwt. lb.	s. d.	s. d.	bu. pk.	cwt. lb.	s. d.	s. d.	L. s. d.	L. s. d.
1	Nothing	... ...	... ...	... ...	... ...	6 7 0	36 48	51 0	9 12 6	3 12 10¼	13 5 4¼	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...
2	Guano, African	1 0	6 9	6 9	0 6 9	6 7 0	37 76	51 3	9 12 6	3 15 4½	13 7 10½	... ...	1 28	... ...	2 6	... ...	... ...	... ...	... ...	... ...	0 4 3
3	Saltpetre refuse	1 0	10 0	10 0	0 10 0	7 5 1	41 108	50 7	10 14 4½	4 3 11	14 18 3½	6 1	5 60	21 10½	11 0¾	... ...	... ...	... ...	... ...	1 2 11¼	... ...
4	Night-soil, prepared	1 0	5 0	5 0	0 5 0	7 2 3	36 48	51 0	10 5 7½	3 12 10¼	13 18 5¾	3 3	... ...	13 1½	... ...	... ...	... ...	... ...	... ...	0 8 1½	... ...
5	Guano	0 37.5	6 9	2 3¼	7 4¼	6 2 0	32 96	51 3	8 15 0	3 5 8½	12 0 8½	... ...	... ...	... ...	... ...	5 0	3 52	17 6	6 11	... ...	1 11 9¼
	Saltpetre	0 37.5	10 0	3 4¼																	
	Night-soil	0 37.5	5 0	1 8¼																	
6	Guano	0 28	6 9	1 8¼	6 8¼	7 4 0	43 44	49 3	10 10 0	4 6 9½	14 16 9½	5 0	6 96	17 6	13 8½	... ...	... ...	... ...	... ...	1 4 6¼	... ...
	Saltpetre	0 28	10 0	2 6																	
	Night-soil	0 28	5 0	1 3																	
	Animal Charcoal	0 56	2 6	1 3																	
7	Guano	0 28	6 9	1 8¼	8 5¼	6 7 1	42 36	51 3	9 13 4½	4 4 7½	13 18 0	0 1	5 88	0 10½	11 6¾	... ...	... ...	... ...	... ...	0 4 0	... ...
	Saltpetre	0 28	10 0	2 6																	
	Night-soil	0 28	5 0	1 3																	
	Sulph. of Magne.	0 28	12 0	3 0																	
8	Guano	0 28	6 9	1 8¼	10 8¼	6 7 0	43 4	51 7	9 12 6	4 6 0¾	13 18 6¾	... ...	6 56	... ...	13 0	... ...	... ...	... ...	... ...	0 2 3¼	... ...
	Saltpetre	0 28	10 0	2 6																	
	Night-soil	0 28	5 0	1 3																	
	Nitrate of Soda	0 28	21 0	5 3																	

TABLE E,

Exhibiting the immediate results of the applications of Special Manures to the Potato crop 1844. Manure applied in the drills with the dung 15th May. Lifted and weighed 20th October 1845. Calculations made per imperial acre. Potatoes estimated by the ton. Common Manure by the ton. Special Manures by the cwt. Potatoes valued at £2 per ton.

No.	Substances employed.	Quantity of farm-yard manure.	Value of ditto per ton.	Quantity of specific manures.	Cost of ditto per cw.	Cost of ditto per acre.	Total cost of ditto per acre.	Cost of both common and special manures.	EFFECTS OF SPECIAL MANU. Produce in bulbs.	EFFECTS OF SPECIAL MANU. Value of bulbs.	ECONOMICAL RESULTS OF SPECIAL MANURE. Excess of produce in bulbs.	Value of excess.	Loss in bulbs.	Value of loss.	Gain from application.	Loss from application.
		tn. cwt	s. d.	cw. lbs.	s. d.	s. d.	L. s. d.	L. s. d.	tn. cw. lb.	L. s. d.	tn. cw. lb.	L. s. d.	tn. cw. lb.	L. s. d.	L. s. d	L. s. d.
1	Farm-yard Dung	25 0	6 0	... ...	... ...	... ...	... ...	7 10 0	7 10 0	15 0 0	... ...	... ...	... ...	... ...	... ...	... ...
2	Farm-yard Dung	20 0	6 0	... ...	... ...	... ...	6 0 0	7 0 3	8 14 32	17 8 6½	1 4 0	2 8 0	... ...	... ...	2 17 9	... ...
	African Guano	... ...	... ...	3 0	6 9	20 3	1 0 3									
3	Farm-yard Dung	20 0	6 0	3 0	... ...	... ...	6 0 0	7 0 0	7 17 16	15 14 3½	0 7 16	0 14 3½	... ...	... ...	1 4 3½	... ...
	Prepared Night-soil	... ...	... ...	4 0	5 0	20 0	1 0 0									
4	Farm-yard Dung	20 0	6 0	... ...	... ...	... ...	6 0 0	6 12 0	7 14 32	15 8 6½	0 4 32	0 8 6½	... ...	... ...	1 6 6½	... ...
	Pigeon Dung	... ...	... ...	4 0	3 0	0 12	0 12 0									
5	Farm-yard Dung	25 0	6 0	... ...	... ...	... ...	7 10 0	8 0 1½	8 12 96	17 5 8½	1 2 96	2 5 8½	... ...	... ...	1 15 8½	... ...
	Guano	... ...	... ...	1 56	6 9	10 1½	0 10 1½									
6	Farm-yard Dung	15 0	6 0	... ...	... ...	... ...	4 10 0									
	Guano	... ...	... ...	2 0	6 9	13 6	... ...									
	Nitrate of Soda	... ...	... ...	0 28	21 0	5 3	... ...									
	Sulphate of Soda	... ...	... ...	0 42	5 6	2 0¾	... ...	5 19 3¾	8 12 16	17 4 3½	1 2 16	2 4 3½	... ...	... ...	3 14 11½	... ...
	Animal Charcoal	... ...	... ...	2 0	2 6	5 0	... ...									
	Gypsum	... ...	... ...	1 0	3 6	3 6	1 9 3¾									
7	Farm-yard Dung	15 0	6 0	... ...	... ...	... ...	4 10 0									
	Night-soil	... ...	... ...	2 0	5 0	10 0	... ...									
	Sulphate of Ammonia	... ...	... ...	1 0	21 0	21 0	... ...									
	Gypsum	... ...	... ...	1 0	3 6	3 6	... ...									
	Pigeon Dung	... ...	... ...	3 0	3 0	9 0	2 3 6	7 7 0	6 2 96	12 5 7½	... ...	... ...	1 7 4	2 14 0½	... ...	2 11 0½
							6 13 6									
	* Guano applied as a top-dressing ext.	... ...	... ...	2 0	6 9	13 6	0 13 6									
8	Farm-yard Dung	15 0	6 0	... ...	... ...	... ...	4 10 0									
	Sulphate of Ammonia	... ...	... ...	1 0	21 0	21 0	... ...									
	Sulphate of Soda	... ...	... ...	1 0	5 6	5 6	... ...									
	Sulphuric Acid	... ...	... ...	0 56	9 4	4 8	... ...	7 6 8	8 7 16	16 14 3¾	0 17 16	1 14 3½	... ...	... ...	1 17 7½	... ...
	Sulphate of Magnesia	... ...	... ...	1 0	12 0	12 0	2 3 2									
							6 13 2									
	Guano applied as a top-dressing extra	... ...	... ...	2 0	6 9	13 6	0 13 6									
	Results of Nos. 7 and 8 without the top-dressing of Guano:—															
7	Cost as above without Guano	... ...	... ...	... ...	... ...	... ...	6 13 6	6 13 6	4 14 32	9 8 6½	... ...	... ...	2 15 68	5 11 2½	... ...	4 14 8½
8	Cost as above without Guano	... ...	... ...	... ...	... ...	... ...	6 13 2	6 13 2	6 2 96	12 5 7½	... ...	... ...	1 7 4	2 14 0½	... ...	1 17 2½

* Extra guano applied 24th July. By the application of the extra guano to Nos. 7 and 8, the loss on No. 7 is reduced from L.4, 14s. 8½d., to L.2, 11s. 0½d., thus gaining, after paying its own cost L.2, 5s. 6d. And the loss in No. 8 of L.1, 17s. 2½d., is converted to a gain of L.1, 17s. 7½d., or, after paying its own cost, leaving a gain over the portion not guanoed of L.3, 14s. 9¾d.

Table F,

Exhibiting the immediate results of the application of Special Manures to the Turnip crop 1845. Manures applied in the drills with the dung 29th May. Lifted and weighed 7th November 1845. Calculations made per imperial acre. Turnips estimated by the ton. Common Manure by the ton. Special Manure by the cwt. Turnips valued at 18s. per ton.

No.		Substances Employed.	Quantity of farm-yard manure.	Value of ditto per ton.	Quantity of specific manure.	Cost of ditto per cwt.	Cost of ditto per acre.	Total cost of ditto per acre.	Cost of both common and specific manures.	Effects of Special Manures. Produce in bulbs.	Value of bulbs.	Produce in tops.	Economical Results of Special Manures. Excess of produce in bulbs.	Value of excess.	Loss in bulbs.	Value of loss in bulbs.	Loss in tops.	Gain from application.
			tn. cw.	s. d.	cw. lb	s. d.	s. d.	L. s. d.	L. s. d.	tn. cw. lb.	L. s. d.	tn. cw. lb.	tn. cw. lb.	L. s. d.	tn. cw. lb.	L. s. d.	tn. cw. lb.	L. s. d.
1		Farm-yard Manure	30 0	6 0	...	...	...	9 0 0	9 0 0	11 0 80	9 18 4½	6 12 96	...	...	...	...	...	...
2	1	Farm-yard Manure	25 0	6 0	...	...	...	7 10 0	7 16 9	12 4 32	10 19 10	6 12 16	1 3 52	1 1 1½	...	...	0 0 80	2 4 4½
		African Guano	...	...	1 0	6 9	6 9	0 6 9										
	2	Farm-yard Manure	25 0	6 0	...	...	...	7 10 0	7 17 6	10 16 8	9 14 5½	5 13 60	...	...	0 3 72	0 3 3	0 19 36	0 19 3
		Prepared Night-soil	...	...	1 56	5 0	7 6	0 7 6										
	3	Farm-yard Manure	25 0	6 0	...	...	...	7 10 0	7 14 6	12 9 12	11 4 2	4 17 16	1 8 32	1 5 6	...	...	1 15 80	2 11 0
		Pigeon Dung	...	...	1 56	3 0	4 6	0 4 6										
3	1	Farm-yard Manure	20 0	6 0	...	...	...	6 0 0	6 13 6	11 12 56	10 9 3	4 15 40	0 11 76	0 14 1½	...	...	1 17 56	3 0 7½
		African Guano	...	...	2 0	6 9	13 6	0 13 6										
	2	Farm-yard Manure	20 0	6 0	...	...	...	6 0 0	6 15 0	9 1 48	8 3 3½	4 1 48	...	...	1 19 32	1 15 4	11 48	0 9 8½
		Prepared Night-soil	...	...	3 0	5 0	15 0	0 15 0										
	3	Farm-yard Manure	20 0	6 0	...	...	...	6 0 0	6 9 0	10 12 56	9 11 8	4 8 24	...	...	0 8 24	0 7 5	2 4 72	2 3 7
		Pigeon Dung	...	...	3 0	3 0	9 0	0 9 0										
4	1	Farm-yard Manure	15 0	6 0	...	...	...	4 10 0	5 10 3	12 11 88	11 6 7	5 15 80	1 11 8	1 7 11½	...	...	0 17 16	4 17 8½
		African Guano	...	...	3 0	6 9	20 3	1 0 3										
	2	Farm-yard Manure	15 0	6 0	...	...	...	4 10 0	5 12 6	8 14 32	7 16 10	3 17 96	...	...	2 6 48	2 1 9½	2 15 0	1 5 8½
		Prepared Night-soil	...	...	4 56	5 0	22 6	1 2 6										
	3	Farm-yard Manure	15 0	6 0	...	...	...	4 10 0	5 3 6	9 2 56	8 11 5½	3 15 0	...	...	1 18 21	1 14 5	2 17 96	2 1 1
		Pigeon Dung	...	...	4 56	3 0	13 6	0 13 6										
5	1	Farm-yard Manure	10 0	6 0	...	...	...	3 0 0	4 7 0	10 18 84	9 16 9½	4 18 64	...	...	0 1 96	0 1 8	1 14 32	4 11 4
		African Guano	...	...	4 0	6 9	27 0	1 7 0										
	2	Farm-yard Manure	10 0	6 0	...	...	...	3 0 0	4 10 0	8 6 48	7 9 9½	3 4 32	...	...	2 14 32	2 8 10½	3 8 64	2 1 1½
		Prepared Night-soil	...	...	6 0	5 0	30 0	1 10 0										
	3	Farm-yard Manure	10 0	6 0	...	...	...	3 0 0	3 18 0	9 2 96	8 11 9½	4 8 24	...	...	1 17 84	1 13 11½	2 4 72	3 8 0½
		Pigeon Dung	...	...	6 0	3 0	18 0	0 18 0										

TABLE G,

Exhibiting the immediate results of the application of Special Manures to the Turnip crop 1845. Manures applied in the drills with the dung 23d June. Lifted and weighed 8th November 1845. Calculations made per imperial acre. Turnips estimated by the ton. Common Manure by the ton. Special Manures by the cwt. Turnips valued at 18s. per ton.

No.	Substances Employed	Quantity of farm-yard manure.	Value of ditto per ton.	Quantity of specific man.	Cost of ditto per cwt.	Cost of ditto per acre.	Cost of both common and specific manures.	Extended cost of ditto per acre.	VEGETATIVE EFFECTS OF SPECIAL MANURES. Produce in bulbs.	Value of bulbs.	Produce in tops.	ECONOMICAL RESULTS OF SPECIAL MANURES. Excess of produce in bulbs.	Value of excess.	Loss in bulbs.	Value of loss in bulbs.	Excess in tops.	Gain from application.
		tn. cw.	s. d.	cwt. lb.	L. s. d.	L. s. d.	L. s. d.	L. s. d	tn. cw. lb	L. s. d.	tn. cw. lb.	tn. cw. lb	L. s. d.	cwt. lb.	s. d.	tn. cw. lb.	L. s. d
1	Farm-yard Manure...	25 0	6 0	... ...	... ...	... ...	7 10 0	7 10 0	15 3 64	13 13 8	5 7 96	... ...	... ...	... ...	... ...	... ...	... ...
2	Farm-yard Manure...	10 0	6 0	... ...	... ...	... ...	3 0 0	4 5 3	21 13 64	19 10 2	6 17 96	6 10 0	5 17 9	... ...	... ...	1 10 0	9 1 9
	African Guano.........	... ...	... ...	3 0	0 6 9	1 0 3	... ...										
	Animal Charcoal......	... ...	... ...	2 0	0 2 6	0 5 0	1 5 3										
3	Farm-yard Manure...	10 0	6 0	... ...	... ...	... ...	3 0 0	4 0 0	18 0 40	16 4 4	5 17 16	2 16 76	2 11 0	... ...	... ...	0 9 20	6 1 0
	Prepared Night-soil.	... ...	... ...	3 0	0 5 0	0 15 0	... ...										
	Animal Charcoal......	... ...	... ...	2 0	0 2 6	0 5 0	1 0 0										
4	Farm-yard Manure...	10 0	6 0	... ...	... ...	... ...	3 0 0	6 5 9	21 5 80	19 2 7	8 14 92	6 2 16	5 9 11	... ...	... ...	3 6 96	6 14 2
	Guano......................	... ...	... ...	3 0	0 6 9	1 0 3	... ...										
	Saltpetre refuse........	... ...	... ...	2 0	0 10 0	1 0 0	... ...										
	Nitrate of Soda	... ...	... ...	1 24	1 1 0	1 5 6	3 5 9										
5	Farm-yard Manure...	10 0	6 0	... ...	... ...	... ...	3 0 0	6 0 6	18 7 16	16 11 4	6 18 64	3 3 52	2 17 2	... ...	... ...	1 10 68	4 6 8
	Night-soil	... ...	... ...	3 0	0 5 0	0 15 0	... ...										
	Saltpetre refuse........	... ...	... ...	2 0	0 10 0	1 0 0	... ...										
	Nitrate of Soda	... ...	... ...	1 24	1 0 0	1 5 6	3 0 6										
6	Farm-yard Manure...	10 0	6 0	... ...	... ...	... ...	3 0 0	5 18 7½	20 0 0	18 0 0	6 18 64	4 16 36	4 6 8½	... ...	... ...	1 10 68	5 18 1
	Guano......................	... ...	... ...	3 0	0 6 9	1 0 3	... ...										
	Sulphate of Magnesia	... ...	... ...	2 20	0 12 0	1 6 1½	... ...										
	Gypsum..................	... ...	... ...	3 56	0 3 6	0 12 3	2 18 7½										
7	Farm-yard Manure...	10 0	6 0	... ...	... ...	... ...	3 0 0	5 13 4½	15 2 16	13 11 11	5 15 80	... ...	... ...	1 48	1 4	0 7 84	1 15 3½
	Night-soil	... ...	... ...	3 0	0 5 0	0 15 0	... ...										
	Sulphate of Magnesia	... ...	... ...	2 20	0 12 0	1 6 1½	... ...										
	Gypsum..................	... ...	... ...	3 56	0 3 6	0 12 3	2 13 4½										

Table H,

Exhibiting the immediate results of the application of Special Manures to the Turnip crop 1845. Manures mixed with ashes and spread on the land previous to ridging, 26th June. Lifted and weighed 8th November 1845. Calculations made per imperial acre. Turnips estimated by the ton. Common Manures by the ton. Special Manures by the cwt. Turnips valued at 18s. per ton.

No.	Substances Employed.	Quantity of farm-yard manure.	Cost of ditto per ton.	Quantity of specific manures.	Cost of ditto per cwt.	Cost of ditto.	Cost of both the common and specific manures.	Extended cost of ditto per acre.	VEGETATIVE EFFECTS OF SPECIAL MANURES. Produce in bulbs.	Value of bulbs.	Produce in tops.	ECONOMICAL RESULTS OF SPECIAL MANURES. Excess of produce in bulbs.	Value of excess.	Loss of produce in bulbs.	Value of loss.	Excess in tops.	Gain from application.
		tn. cwt.	s. d.		L. s. d.	L. s. d.	L. s. d.	L. s. d.	tn. cw. lb.	L. s. d.	tn. cw. lb.	tn. cw. lb.	L. s. d.	cwts. lb.	s. d.	tn. cw. lb.	L. s. d.
1	Farm-yard Manure...	25 0	6 0	... ...	... ...	... ...	7 10 0	7 10 0	15 3 64	13 13 3	5 7 96	... ...	... ...	... ...	... ...	... ...	... ...
2	Bones dissolved in	... ...	... ...	32 bu.	per boll. 0 10 6	4 4 0	5 0 8	5 0 8	14 8 64	12 19 9½	5 17 16	... ...	... ...	0 15	13 6	0 9 20	1 15 10
	Sulphuric Acid......	... ...	... ...	2 cwt.	per cwt. 0 8 4	16 8											
3	Bones dissolved in	... ...	... ...	12 bu.	per boll. 0 10 6	1 11 6											
	Sulphuric Acid......	... ...	... ...	cwt. lbs. 1 56	per cwt. 0 8 4	0 12 6	3 2 6	3 2 6	15 14 72	14 2 2	5 17 16	0 11 8	0 9 11½	... ...	... ...	0 9 20	4 17 5½
	African Guano.........	... ...	... ...	2 0	0 6 9	0 13 6											
	Animal Charcoal......	... ...	... ...	2 0	0 2 6	0 5 0											
4	Bones dissolved in	... ...	... ...	12 bu.	per boll. 0 10 6	1 11 6											
	Sulphuric acid......	... ...	... ...	cwt. lbs. 1 56	per cwt. 0 8 4	0 12 6	2 19	2 19 0	15 16 48	14 4 10	9 32	0 12 84	0 11 5½	... ...	... ...	0 1 36	5 2 5½
	Prepared Night-soil..	... ...	... ...	2 0	0 5 0	0 10 0											
	Animal Charcoal......	... ...	... ...	2 0	0 2 6	0 5 0											
5	Bones dissolved in	... ...	... ...	8 bu.	per boll. 0 10 6	1 1 0											
	Sulphuric Acid......	... ...	... ...	1 cwt.	per cwt. 0 8 4	0 8 4	2 12 10	2 12 10	18 1 48	16 5 4	6 18 64	2 17 81	2 11 11½	... ...	... ...	1 10 68	7 9 1½
	African Guano.........	... ...	... ...	2 0	0 6 9	0 13 6											
	Prepared Night-soil..	... ...	... ...	2 0	0 5 0	0 10 0											

SECTIONS OF TABLE A.—Exhibiting the results of the application of Special Manures upon Sown Grasses, Crop 1845.

Geological Formation of the District.	Altitude and general Meteorological Conditions of the Farm.	If Drained, when, in what manner, and to what depth?	If Trenched or Subsoil-ploughed, and to what depth?
	About 460 feet about the level of the sea. Of a climate about third rate, being in a direct line, 9 miles or thereby, from the sea. Heaviest gales of wind from the west. The atmosphere partakes of the variableness of the country generally, but not particularly damp. Locality healthy.	The field was drained in the winter of 1841. Drains 16 feet apart. Broken land. Stones placed above the tiles. Drains 20 inches deep in the cut, but in consequence of the height of the ridges when drained, the depth is now 2 feet fully.	Neither trenched nor subsoil-ploughed.

Previous Culture of the Soil.	When Manured.	Nature of Manure.	Quantity of Manure applied.	If Lime has been applied, when, and what quantity per acre?
1842, oats from lea, one year-old. 1843, potatoes. 1844, wheat, sown with grasses.	In 1842, composted with lime to oats. In 1843, to potatoes. In 1844, to wheat.	1842, lime compost. 1843, farm-yard manure. 1844, African guano.	1844, 60 to 80 carts compost 1843, 30 tons farm-yard manure. 1844, 2 cwt. guano top-dressed, one half of the field in autumn with wheat, the other half in spring.	In 1842, from 60 to 80 carts lime-compost applied per Scotch acre.

Name and Variety of the Crop experimented on.	Date of Sowing.	Progress and Appearances during Growth.				Diseased Appearances, and what form assumed.	Date of Reaping.	Date of Thrashing.
Sown grasses and clover. Perennial rye grass, and red and white clover.		April.—	May.—In the last week of this month, the progress and appearance stand in the notes thus—8, 4, 9, 3, 10, 7, 1, 2, 5, 6.	June. — During this month Nos. 9 and 7 outstripped No. 4 in appearance, and they are noted thus—8, 9, 7, 4, 3, 10, 1, 2, 5, 6.	July. — No difference distinguishable. The relative position of each number continued the same, till cut, as in last month.	None.	18th July 1845.	

Sections of Table B.—Exhibiting the results of the application of Special Manures top dressed on the Oat Crop 1845.

Geological Formation of the District.	Altitude and general Meteorogical Conditions of the Farm.	If Drained, in what manner, and to what depth?	If Trenched or Subsoil-ploughed, when, and to what depth?
		Drained in the winter of 1844, without stones, the sod placed above the tiles. Drains 16 feet apart—20 inches deep when cut, now, from the height of the ridges previously, the drains measure fully 2 feet.	Neither as yet. To be subsoil-ploughed this winter.

Previous Culture of the Soil.	When Manured.	Nature of Manure.	Quantity of Manure applied.	If Lime has been applied, when, and what quantity per acre?
As the field only came into possession in 1844, nothing can be said of the previous culture, beyond the fact that it was in grass cut for hay in 1843.	Not known.	Not known.	Not known.	Not known.

Name and Variety of the Crop experimented on.	Date of Sowing.	Progress and Appearances during Growth.				Diseased appearances, and what form assumed.	Date of Reaping.	Date of Thrashing.
Oats of the Hopetoun variety.	1st April 1845.	April.—	May. — The manures were applied on the 26th of this month, consequently no progress observable.	June.—No. 2 early took the lead in appearance, and kept it till the end, and the numbers are noted relatively thus—2, 4, 10, 9, 7, 5, 6, 8, 11, 12, 13, 3, 1.	July. — During this month, and till reaped, the relative positions as to appearances remained the same, but the promise of straw was greatly in favour of Nos. 4, 10, and 9.	None.	1st October 1845.	16th October 1845.

SECTIONS OF TABLE C.—Exhibiting the results of the application of Special Manures top-dressed upon the Wheat Crop 1845.

Geological Formation of the District.	Altitude and general Meteorological Conditions of the Farm	If Drained, in what Manner, and to what Depth?	If Trenched or Subsoil-Ploughed, when, and to what Depth?
		Drained in the autumn of 1844, without stones, straw laid thinly above the tiles. Drains 16 feet apart, and 20 inches deep, now, in consequence of high ridges, the drains are 2 feet deep.	Neither as yet. To be subsoil ploughed this winter.

Previous Culture of the Soil.	When Manured.	Nature of Manure.	Quantity of Manure applied.	If Lime has been applied, when, and what quantity per acre?
As this field only came into possession in 1844, nothing is known of the previous culture, beyond the fact that it lay fallow during that year.	With wheat in the autumn of 1844.	Rape-dust, applied broad cast and harrowed in with wheat.	14 cwt. per Scotch acre.	Not known.

Name and Variety of the Crop experimented on.	Date of Sowing.	Progress and Appearances during Growth.				Diseased appearances, and what form assumed.	Date of Reaping	Date of Thrashing.
Wheat, of the Hunter's variety.	27th September 1844.	April.—	May.—Towards the latter end of this month No. 5 had taken effect No perceptible improvement in the other numbers.	June.—No. 5 leading decidedly. On the 16th of this month, the relative position of the numbers are noted thus—5, 4, 3, 6, 9, 8, 7, 1, 2.	July. — During this month, and till reaped, the only change noted is placing No. 3 in a prior position to No. 4. The rest in *statu quo*.	On one side of the ear, 2, 4, and in some cases as many as 6 and 8 pickles empty, otherwise no disease.	24th September 1845.	11th October 1845.

SECTION OF TABLE D.—Exhibiting the results of the application of Special Manures top-dressed upon the Barley Crop 1845.

GEOLOGICAL FORMATION OF THE DISTRICT.	ALTITUDE AND GENERAL METEOROLOGICAL CONDITIONS OF THE FARM.	IF DRAINED, IN WHAT MANNER, AND TO WHAT DEPTH?	IF TRENCHED OR SUBSOIL-PLOUGHED, WHEN, AND TO WHAT DEPTH?
		Drained in 1841 with Stones laid above the tiles to the depth of seven inches. Drains 16 feet apart, and cut 20 inches deep—will now measure fully 2 feet.	Neither trenched nor subsoil-ploughed.

PREVIOUS CULTURE OF THE SOIL.	WHEN MANURED.	NATURE OF MANURE.	QUANTITY OF MANURE APPLIED.	IF LIME HAS BEEN APPLIED, WHEN, AND WHAT QUANTITY PER ACRE?
1841. Fallow. 1842. Turnips, eaten on with sheep. 1843. Oats. 1844. Turnips, one third eaten on with sheep.	In 1842, to turnips. In 1844 to turnips.	Farm-yard manure.	1842, 30 tons per Scotch acre. 1844, 25 ditto per ditto.	Limed this year (1845) to barley and grass, at the rate of 60 bolls per Scotch acre.

NAME AND VARIETY OF THE CROP EXPERIMENTED ON.	DATE OF SOWING.	PROGRESS AND APPEARANCES DURING GROWTH.				DISEASED APPEARANCES, AND WHAT FORM ASSUMED.	DATE OF REAPING.	DATE OF THRASHING.
Barley of the Chevalier variety.	2d May 1845.	April.—	May.—No material improvement noticed this month.	June.—Second week of this month, No. 8 leading. Relative position of numbers noted thus—8, 3, 6, 7, 2, 4, 1, 5.	July.—No. 8 still leading. No. 6 takes the place of No. 3. Relative position of numbers noted thus—8, 6, 3, 7, 2, 4, 1, 5.	None.	20th September 1845.	15th October 1845.

SECTIONS OF TABLE E.—Exhibiting the results of the application of Special Manures to the Potato Crop 1845.

Geological Formation of the District.	Altitude and general Meteorological Conditions of the Farm.	If Drained, in what manner, and to what depth?	If Trenched or Subsoil-ploughed, when, and to what depth?
		5-6ths of the field of a gravelly subsoil, draining not required. The remaining portion wet sand, drained this year to a depth varying from 2 feet to 20 inches, 13 feet apart, without stones; straw thinly laid on.	Not required.

Previous Culture of the Soil.	When Manured.	Nature of Manure.	Quantity of Manure applied.	If Lime has been applied, when, and in what quantity per acre?
1843, oats, after old lea. 1844, oats.	15th May 1845.	Farm-yard dung and guano.	24 tons of dung, 3 cwt. of guano—this in the part not experimented on. The experimental part was manured as shown in Table E.	Not limed since possession was obtained. Not aware of any previous liming.

Name and Variety of the Crop experimented on.	Date of Planting.	Progress and Appearance during Growth.				Diseased appearances, and what form assumed.	Date of Lifting.	Date of Weighing.
Potatoes, of the Don variety.	15th May 1845.	April.—	May.—Crop not brairded.	June.—Brairded second week of this month; No. 2 first, Nos. 7 and 8 last. Noted thus—2, 6, 5, 4, 3, 1, 8, 7, in the last week of this month.	July.—No difference observable this month in the relative positions. After top-dressing with guano, noted in the first week of August thus—8, 2, 6, 5, 4, 3, 1, 7.	Affected with curl. Some plants more so than others. In general, however, the shaw was strong and branchy. No. 8 presented a decidedly healthy appearance.	20th October 1845.	20th October 1845.

SECTIONS OF TABLE F.—Exhibiting the results of the application of Special Manures to the White Globe Turnip, Crop 1845.

GEOLOGICAL FORMATION OF THE DISTRICT.	ALTITUDE AND GENERAL METEOROLOGICAL CONDITIONS OF THE FARM.	IF DRAINED, IN WHAT MANNER, AND TO WHAT DEPTH?	IF TRENCHED OR SUBSOIL-PLOUGHED, WHEN AND TO WHAT DEPTH?
		About one-third of the field, resting on a wet sandy subsoil, was drained in 1843. Gravel put above the tiles Drains cut 2 feet deep The remainder of the field rests on gravel, and is quite dry.	Not required.

PREVIOUS CULTURE OF THE SOIL.	WHEN MANURED.	NATURE OF MANURE.	QUANTITY OF MANURE APPLIED.	IF LIME HAS BEEN APPLIED, WHEN, AND IN WHAT QUANTITY PER ACRE?
1842, oats, after lea, one year-old. 1843, turnips. 1844, oats.	In 1843, to turnips; and in 1845, to ditto.	In 1843, farm-yard manure and bones In 1845, farm-yard manure and the other substances, See Table F.	1843, 20 tons farm-yard manure, and 6 bushels of bones 1845, See Table F.	Not limed since in possession. Nothing known of a previous liming.

NAME AND VARIETY OF THE CROP EXPERIMENTED ON.	DATE OF SOWING.	PROGRESS AND APPEARANCE DURING GROWTH.				DISEASED APPEARANCES AND WHAT FORM ASSUMED	DATE OF LIFTING.	DATE OF WEIGHING
Turnips, white globe variety	29th May 1845.	June.—No. 1 of lot 4; leading; lots in the gross noted thus—Nos. 2, 3, 4, 1, 5 The No ones of these lots had the superiority of No twos and threes, threes superior to twos.	July. — No variation noted during this month.	August —All in statu quo, till the end of the month, when in appearance No. 1 of the lots in the gross shot a-head.	September – No. 1 of the gross lots still leading, and the appearance noted thus —Nos 1, 2, 3, 4, 5. In promise of turnips the notes stand thus —2, 3, 4, 1, 5.	None	7th Nov. 1845.	7th Nov 1845

OBSERVATIONS OF TABLE G.—Exhibiting the results of the application of Special Manures to the Green top Globe Turnip Crop 1845

Geological Formation of the District	Altitude and Meteorological Conditions of the Farm	If Drained, in what manner, and to what depth?	If Trenched or Subsoil Ploughed, when, and to what depth?
		Soil light Subsoil gravelly sand Dry	Not necessary

Previous Culture of the Soil	When Manured	Nature of Manure	Quantity of Manure applied	If Lime has been applied, when, and what quantity per acre?
1844, oats, after old lea	In 1845	The portion of the field not experimented on farm yard manure and guano For the manuring of the experimental portion, see Table G	Farm yard manure 16 tons guano, 3 cwt, per Scotch acre For the other portions of field, see Table G.	No lime applied since in possession

Name and Variety of the Crop experimented on	Date of Sowing	Progress and Appearances during Growth				Diseased Appearances and what form assumed	Date of Lifting	Date of Weighing
Turnips of the green top globe variety	26th June 1845	June –	July Braird.d equally, and at the thinning presented little variety No 4, if any thing, had the advantage	August —No 4 decidedly superior, with the exceptions of Nos 1 and 7, the other numbers differed nothing in appearance	September — During this month No 4 still in advance—the rest as before In October Nos 2 and 3 kept their growth longer, and continued vigorous till lifted	None.	8th Nov 1845	8th Nov 1845

SECTIONS OF TABLE H.—Exhibiting the results of the application of Special Manures to the Green-top Globe Turnip Crop 1845.

Geological Formation of the District.	Altitude and general Meteorological conditions of the Farm.	If Drained, when, in what manner, and to what depth?	If Trenched or Subsoil-ploughed, when, and to what depth?
		The same description of soil and subsoil as above.	As above.

Previous Culture of the Soil.	When Manured.	Nature of Manure.	Quantity of Manure applied.	If Lime has been Applied, when, and what quantity per acre?
Same as above.	Same as above.	Same as above.	Same as above.	Same as above.

Name and Variety of the Crop Experimented on.	Date of Sowing.	Progress and Appearances.				Diseased Appearances, and what form assumed.	Date of Lifting.	Date of Weighing.
Turnips of the green-top globe variety.	26th June 1845.	June.—	July.—Brairded equally. When thinned, No 5 superior to the others.	August.—No. 5 leading, the others presented no variety of appearance.	September.—The same remarks apply to this month as for August. When lifted, No. 5 was much more vigorous than the others.	None.	8th November 1845.	8th November 1845.

ANALYSES OF SOILS MADE BY PROFESSOR JOHNSTON—1845.

Substances.	Analysis of Soil, Table A.	Ditto, Table B.	Ditto, Table C.	Ditto, Table D.	Ditto, Table E.	Ditto, Table F.	Ditto, Tables G and H.
I. BY WASHING.							
Quartz, Sand, and Stones.	49.85	50.0	46.2	68 2	70.8	76 0	69.37
Clay and Organic Matter.	50.15	50.0	53.8	31.8	29.2	24.0	30.63
	100.00	100.0	100.0	100 0	100 0	100 0	100 00
Water in the samples sent	19.95	14.07	14.81	13.32	15.60	14.02	16.02
II. BY ANALYSIS.							
Organic Matter . . .	7.13	7.68	4.14	6.88	4.46	8.52	9.23
Alkaline Salts, soluble in water and acids . .	0.11	0.06	0.12	0.25	0.11	0.21	0.13
Gypsum	0.11	0 09	0.10	0 06	0.07	0.09	0.04
Oxide of Iron. In Tables A, and G, and H, a little phosphate is found .	3.98	5.05	5.00	3.59	2 92	2.60	3.62
Alumina, soluble in acids	1.33	1.53	1.30	1.46	0 72	1.06	0.82
Carbonate of Lime . .	2.16	0.97	0 93	0.70	0.61	0.84	0.95
Carbonate of Magnesia	0.86	0.66	0 52	0.43	0.37	0.41	0.85
Soluble Silica	0.00	0.06	0.07	0.03	0.03	0.03	0 00
Insoluble silicious matter	84 33	84.76	87.31	86.83	90.16	85.55	84.08
	100.01	100.26	99.49	100.23	99.45	99.31	99.72

REPORT ON THE DISEASE OF THE POTATO CROP IN SCOTLAND IN THE YEAR 1845.

The Highland and Agricultural Society of Scotland, impressed with the importance of placing on record the results of the experience of agriculturists regarding the disease which had so widely affected the potato crop of last year, directed attention to the subject in the following paper, which has been widely circulated in the agricultural districts of Scotland:—

"ON THE DISEASE OF POTATOES.

"The Highland and Agricultural Society of Scotland, desirous of obtaining information regarding the disease which has so recently affected the Potato crops of this country, earnestly solicits the co-operation of Societies and individuals in the collecting of

such facts, regarding the nature and effects of the disease, as the experience of agriculturists in different parts of the country can supply.

"Although certain diseases, as curl, ulceration of the tubers, &c., are known to have attacked the Potato plant, since the period of its extended cultivation in these Islands, yet these having been local and partial, have never excited alarm for the safety of the general crop. For several years past, however, there have been partial failures of crops, apparently from the sets undergoing decomposition in the ground after being planted, and before they had put forth stems and leaves. But in the disease now in question, which has excited such general alarm, the plants have appeared to grow vigorously in their first stages, and only to become perceptibly or seriously affected as the tubers advanced towards maturity. What the predisposing causes may be of this dangerous disease we do not as yet know. These causes may, perhaps, escape our knowledge, and may, as in the case of many other diseases of plants, be beyond our control, and all that may be within our power may be to alleviate the effects. The disease has more than once ravaged large tracts of country in North America. Several years ago it appeared in the extreme west of Scotland, as in the island of Mull, and a few other of the Hebrides; but it was only in the past year that it spread over the greater part of Europe. We may indulge the hope, perhaps, that it may not return, or may not occur with the same violence; but we cannot have any assurance that this expectation will be realized, and, therefore, the Society has felt it to be a public duty, to endeavour to collect the information on the subject, which the experience of the past season can afford.

"The points upon which the Society is especially desirous to obtain information are:

"1. At what period in the season, and after what state of the weather, the disease manifested itself, what were the general appearances presented by the stems, leaves, and flowers, and by the tubers, when the taint had extended itself to them.

"2. Whether any of the varieties of Potatoes commonly cultivated have escaped the disease, or been less affected than the others; whether potatoes recently obtained from seeds, have been less subject to it than those which have been long raised from sets or tubers; whether any particular condition of the soil, as to wetness, previous cultivation, or the kinds of manures used, appear to have had any influence in promoting, retarding, or preventing, the disease.

"3. What have been the modes employed in storing the Potatoes, and what are the means which have been found most suc-

cessful in preserving the healthy tubers, and preventing the extension of the taint from the diseased to the sound ones.

"It is to these latter points that the Society is especially desirous of calling the attention of the Agriculturists of Scotland. The Society is aware that Farmers have employed various means for securing the crop, as by ventilating the heaps, by the use of lime and other substances for absorbing moisture, by a frequent opening of the stores, and separation of the diseased from the sound tubers, &c. It is conceived to be of great importance to ascertain the results of those trials, and the further means which the experience of the growers may suggest, for preserving the crop, in case, unfortunately, the disease should again appear in the present or subsequent seasons.

"Highland and Agricultural Society's Hall,
Edinburgh, 10*th February* 1846."

In answer to these inquiries, Reports have been received from most of the counties in Scotland where the disease had manifested itself. The Society proposes, in the first place, to direct attention generally to the information communicated in the Reports, and then to give an Appendix, containing the several communications, which will be found to embrace the various subjects of inquiry as set forth in the printed circular. And the disease having re-appeared, in an aggravated form, in the present year, the Society will probably find it expedient to furnish a Supplementary Report, founded on the experience of the present season; and it invites its numerous and intelligent correspondents to continue to direct their attention to the subject, and furnish the Society with such further observations as they may be enabled to make.

Query First.

At what period in the season, and after what state of the weather, did the disease manifest itself; what were the general appearances presented by the stems, leaves, and flowers, and by the tubers when the taint had extended itself to them?

1st. *Period at which the Disease manifested itself.*

The statements received are various and conflicting as to the time when the disease was first observed. This may be supposed to have arisen in part from the different states of advancement of the crop, and in part from the attention of growers not having been especially directed to a disease of which they had no previous experience, and the existence of which was often unsus-

pected until a late period. In some cases the disease was observed in the month of July, but chiefly in the latter part of August, and in September and October. In some cases it was not noticed till the crop was in the course of being lifted, and it not unfrequently happened that the crop was raised in good condition, and continued apparently free from any considerable taint until some time after being stored.

2d. *State of the Weather.*

The cold and ungenial nature of last season has naturally attracted the attention of the Reporters, though they do not agree as to the precise state of the weather at the period when the disease first appeared. No general conclusion, therefore, can be drawn from the information communicated under this head.

3d. *The Appearances presented by the Stem, Leaves, Flowers, and Tubers.*

Little information is communicated regarding the flowers, which had generally decayed in the natural course before the disease had extended itself. With respect to the appearance of the stem and foliage, the Reporters all concur, though expressing themselves differently, in describing the leaves as presenting the appearance which they generally do after having been injured by severe frost.

In many cases the disease was observed in the tubers, while the growth of the foliage was unchecked, and its appearance unchanged, and in many it was most virulent where the stem and leaves appeared the healthiest and most luxuriant. Statements corroborative of this fact will be found in the Appendix in the Reports of

Mr Gavin Dunlop, Aberdeenshire, . .	No. 4
Mr Dugald M'Dougall, Argyleshire, .	— 11
Mr William Kennedy, do., . .	— 16
Captain Alexander Montgomerie, Ayrshire, .	— 22
Mr John C. Colquhoun, Dumbartonshire, .	— 41
Mr Alexander J. Main, Edinburghshire, .	— 65
Mr Robert Russell, Fifeshire, . .	— 71
Lord Arbuthnot, Kincardineshire, . .	— 79
Mr James Vallentine, Kincardineshire, .	— 84
Mr Andrew Douie, Kinross-shire, . .	— 86
Mr Robert Findlay, Lanarkshire, . .	— 90
Mr Angus Ross, do., . .	— 92
Mr Peter Algie, Renfrewshire, . .	— 114
Mr John Brock, sen., do., . .	— 115
Mr A. F. Gardner, do., . .	— 117
Mr John Dudgeon, Roxburghshire, . .	— 122

As somewhat similar appearances may be presented when the

stems and leaves are injured in their growth by early frost and severe winds, many gentlemen were prevented from giving that attention to those peculiar symptoms which are now well understood to indicate the presence of the disease, as in the cases of

Mr John J. Burnett, Ayrshire, - - -	No. 21
Mr Hugh Speirs, do., - - - -	— 25
Mr Wm. Hope Smith, Berwickshire, - -	— 36
Mr Robert Hewitson, Dumfries-shire, - -	— 47
Mr John Girdwood, Edinburghshire, - -	— 59

The periods at which these symptoms of disease were observed in the stem and leaves varied. They were observed

In July, by Mr Samuel Mitchell, Argyleshire, - -	No. 20
Mr Robert Elliot, Dumfries-shire, - -	— 45
Colonel D. H. Macdowall, Renfrewshire, -	— 116
In August, by Mr W. F. Campbell, of Islay, Argyleshire,	— 8
Mr John Findlay, Ayrshire, - - -	— 28
Mr James M'Kelvie, do., - - - - -	— 29
Mr Alexander M'Caw, do., - - -	— 30
Mr John Hogarth, Berwickshire, - -	— 35
Mr D. Montgomery, Dumbartonshire, - -	— 44
Mr Alexander Stevenson, Dumfries-shire, -	— 46
Mr P. Hume, Fifeshire, - - - -	— 66
Mr James Kerr, do., - - - -	— 68
Mr David Syme, Kinross, - - -	— 85
Mr Francis Maxwell, Kirkcudbright, - -	— 89
Mr James Walker, Linlithgowshire, - -	— 96
Mr Thomas Glen, Renfrewshire, - -	— 113
Mr Robert Nisbet, Roxburghshire, - -	— 121
Mr John Dinwoodie, Wigtonshire, - -	— 132
In the end of August, or beginning of September, by Mr Alexander Finlay, Argyleshire, - - -	— 6
Mr James M'Innes, Argyleshire, - -	— 18
Mr D. Cuninghame, do., - - -	— 24
Mr John Paterson, Arran, - - -	— 37
Mr James Johnston, Dumbartonshire, - -	— 42
Mr James Cousin, Perthshire, - - -	— 107
Sir John S. Richardson, do., - -	— 108
Mr A. F. Gardner, Renfrewshire, - -	— 117
In September, by Dr D. Macfarlane, Argyleshire, -	— 7
Mr Allan M'Dougall, do., - -	— 10
Mr Alexander Gordon, Argyleshire, - -	— 12
Mr William Rutherford, do., - - -	— 15
Mr James M'Innes, do., - - -	— 18
Mr John Lade, Ayrshire, - - -	— 23
Mr Alexander M'Caw, Ayrshire, - -	— 30
Mr William M'Live, do., - - -	— 31
Mr George Darling, Berwickshire, - -	— 34
Dr J. L. Russell, Dumfries-shire, - -	— 48
Mr David Don, Fifeshire, - - -	— 67
Messrs Young, do, - - -	— 69
Mr James Bruce, Haddingtonshire, - -	— 73
Mr Francis M'Minn, Lanarkshire, - -	— 94
Mr Archibald Gorrie, Perthshire, - -	— 105

	Sir David Dundas, Perthshire, - - -	No. 109
	Mr Robert Boyd, Peebles-shire, - - -	— 111
	Mr William Glen, Renfrewshire, - -	— 112
	Sir James Russell, Selkirkshire, - -	— 128
In October, by	Mr Alexander Scott, Edinburghshire, -	— 57
	Mr John Finnie, do., -	— 63
	Mr Andrew Howden, Haddingtonshire, - -	— 74
	Mr Andrew Douie, Kinross-shire, - -	— 86

Three cases in July.
Fifteen in August.
Eight in end of August or beginning of September.
Eighteen in September.
Four in October
In all, Forty-eight.

With respect to the tubers, the periods at which the symptoms of disease and decay manifested themselves, varied considerably. The tubers were observed to be affected

In August, by	Mr Campbell of Islay, Argyleshire, -	No. 8
	Mr James Paterson, Ayrshire, - - -	— 27
	Mr James Kerr, Fifeshire, - - -	— 68
In September, by	Mr James M'Innes, Argyleshire, - -	— 18
	Mr D. Montgomery, Dumbartonshire, - -	— 44
	Mr Robert Hewitson, Dumfries-shire, - -	— 47
	Messrs Young, Fifeshire, - - -	— 69
	Mr Archibald Gorrie, Perthshire, - -	— 105
	Mr Jams Cousin, do., - -	— 107
	Mr Robert Boyd, Peebles-shire, - - -	— 111
	Mr A. F. Gardner, Renfrewshire, - -	— 117
In October, by	Mr John J. Burnett, Ayrshire, - -	— 21
	Mr James M'Kelvie, do., - -	— 29
	Mr John Wilson, Berwickshire, - -	— 33
	Mr John Girdwood, Edinburghshire, - -	— 59
	Mr A. F. Allan, do, - -	— 61
	Mr John Finnie, do., - -	— 63
	Mr John Dickson, do., - -	— 64
	Mr Andrew Howden, Haddingtonshire, - -	— 74
	Mr Andrew Douie, Kinross-shire, - -	— 86
	Sir J S. Richardson, Perthshire, - -	— 108
	Mr William Glen, Renfrewshire, - -	— 112
	Mr Peter Algie, do., - -	— 114
	Colonel Macdowall, do., - -	— 116
When being lifted or pitted, by	Mr Campbell of Islay, Argyleshire, - - - - - -	No. 8
	Mr M. N. Campbell, do., - - -	— 17
	Mr William Hope Smith, Berwickshire, - -	— 36
	Mr Andrew Gibson, Edinburghshire, - -	— 58
	Mr Robert Russell, Fifeshire, - - -	— 71
	Mr Robert Walker, Kincardineshire, - -	— 78
	Mr Alexander Mackie, do., - -	— 80
	Mr George Whittit, junior, Linlithgowshire, -	— 95
	Mr John Dudgeon, Roxburghshire, - -	— 122

In the following cases the crop was lifted and stored without

any appearance of disease; which, however, afterwards broke out:—

Mr John Clerk, Argyleshire, - - -	No. 9
Mr Allan M'Dougall, do., - - -	— 10
Mr Dugald M'Dougall, do., - - -	— 11
Mr William Kennedy, do., - - -	— 16
Mr A. K. Mackinnon, Skye, - - -	— 75
Mr James Falconer, Kincardineshire, - -	— 82
Mr Thomas Glen, Renfrewshire, - -	— 113

With regard to the appearance of the tainted tubers, little can be added to that which is now so familiar, and the descriptions will be best given in the words of the reporters themselves. Nearly all of them, it will be seen, agree in their general account of the appearances presented, commencing with brownish spots on the skin or underneath it, which, gradually increasing, spread into dark-coloured streaks or patches, penetrating with the progress of the disease into the substance of the tuber, and giving it the appearance frequently referred to of an apple bruised by a fall. In a more advanced stage, the diseased part formed irregular ulcers, emitting an offensive odour. In many cases the whole became entirely rotten. In other cases, when the potatoes were properly stored, the disease was stayed, and the sore shrivelled up and dried. Mouldiness about the eyes was not unfrequent, and it is sometimes remarked, that the part of the tuber next the stem was the soonest and most severely affected. When the potato was boiled, the tainted portion in its earlier stage was sweet-tasted, but of a disagreeable smell. The tainted tubers were largely employed for the feeding of cattle and hogs, and no remarks are made regarding any subsequent effects on the health of the animals. In certain cases, the disease appeared partially in the tubers, and extended itself slowly. In other cases, the crop in whole fields seemed to be suddenly and simultaneously affected, a few days only intervening between a state of apparent soundness, and one of commencing decay.

Query Second.

Whether any of the varieties of Potatoes commonly cultivated have escaped the disease, or been less affected than the others; whether potatoes recently obtained from seeds, have been less subject to it than those which have been long raised from sets or tubers; whether any particular condition of the soil, as to wetness, previous cultivation, or the kinds of manures used, appear to have had any influence in promoting, retarding, or preventing the disease?

1st. *Degree in which the Different Varieties were Affected.*

The information communicated under this head is very ample. It may be stated as the general result, that, with the exception of those early potatoes which had reached maturity soon in the season, no variety entirely escaped, although certain sorts were comparatively slightly affected, though grown under similar circumstances with the others. That those early kinds which were matured soon in the season, were either untainted or much less diseased than the others, will be found stated in the reports of

Mr W. F. Campbell, Argyleshire,	-	-	No. 8
Mr John Findlay, Ayrshire,	-	-	— 28
Mr John Wilson, Berwickshire,	-	-	— 33
Dr J. L. Russell, Dumfries-shire,	-	-	— 48
Mr John Girdwood, Edinburghshire,	-	-	— 59
Mr North Dalrymple, Lanarkshire,	-	-	— 93
Mr James Walker, Linlithgowshire,	-	-	— 96
Colonel D. H. Macdowall, Renfrewshire,		-	— 116

The variety called the Second Early, when alluded to, is generally mentioned as having escaped well.

Mr Robert Elliot, Dumfries-shire,	-	-	No. 45
Mr Alexander Stevenson, do,	-	-	— 46
Mr Robert Nisbet, Roxburghshire,	-	-	— 121
Mr John Dudgeon, do.,	-	-	— 122

The American Early has, with few exceptions, been reported to have suffered less than any variety except the Irish Cup, as referred to by

Mr W. F. Campbell, Argyleshire,	-	-	No. 8
Mr J. J. Burnett, Ayrshire,	-	-	— 21
Mr William Hope Smith, Berwickshire,		-	— 36
Mr John Girdwood, Edinburghshire,	-	-	— 59
Colonel Briggs, Fifeshire,	-	-	— 70
Sir Ralph Anstruther, do,	-	-	— 72
Mr James Farquharson, Kincardineshire,		-	— 83
Mr Andrew Douie, Kinross-shire,	-	-	— 86
Mr Robert Findlay, Lanarkshire,	-	-	— 90
Mr William Glen, Renfrewshire,	-	-	— 112
Sir James Russell, Selkirkshire,	-	-	— 128
Mr John Dinwoodie, Wigtonshire,	-	-	— 132

The variety termed the Cup, a very generally cultivated sort, seems in all parts of the country to have been more free from disease than any of the other sorts except the American Early, and in one or two instances in which the latter failed, the former was good. In every other reported case, except one, the Cup was either less tainted than, or as little tainted as, the best of the other varieties, as will be seen from the Reports of—

Dr D. Macfarlane, Argyleshire, - - -	No. 7
Mr W. F. Campbell, do., - - -	— 8
Mr Alexander Gordon, do., - - -	— 12
Mr William Kennedy, do., - - -	— 16
Mr Mungo N. Campbell, do., - - -	— 17
Mr Samuel Mitchell, do., - - -	— 20
Mr John I ade, Ayrshire, - - -	— 23
Mr D. Cuninghame, do., - - -	— 24
Mr James Paterson, do., - - -	— 27
Mr John Findlay, do., - -	— 28
Mr Alexander M'Caw, do., - - -	— 30
Mr Thomas Brown, do., - - -	— 32
Mr George Darling, Berwickshire, - -	— 34
Mr John Hogarth, do., - -	— 35
Mr John Paterson, Arran, - - -	— 37
Mr John C. Colquhoun, Dumbartonshire, -	— 41
Mr James Johnston, do., - -	— 42
Mr Alexander Stevenson, Dumfries-shire, -	— 46
Dr J. L. Russell, do., - -	— 48
Mr John Dickson, Edinburghshire, - -	— 64
Mr David Don, Fifeshire, - - -	— 67
Mr R. Murdoch, Lanarkshire, - - -	— 91
Mr Francis M'Minn, do., - - -	— 94
Mr James Walker, Linlithgowshire, - -	— 96
Mr Robert Boyd, Peebles-shire, - - -	— 111
Mr William Glen, Renfrewshire, - -	— 112
Mr Allan Pollok, jun., do., - -	— 118
Mr Robert Nisbet, Roxburghshire, -	— 121
Mr John Dudgeon, do., - - -	— 122

Other varieties, which it is unnecessary here to specify, are referred to in the Appendix as having escaped, or been less affected than the others. In general it may be said that the coarser varieties suffered less than the finer and more delicate kinds. This is noticed and reported by—

Mr James M'Kelvie, Ayrshire, - - -	No. 29
Mr Robert Elliot, Dumfries-shire, - -	— 45
Mr Robert Russell, Fifeshire, - - -	— 71
Mr Francis Maxwell, Kirkcudbright, - -	— 89
Mr Archibald Gorrie, Perthshire, - -	— 105
and others.	

2d. *Whether potatoes recently obtained from seeds have been less subject to the disease than those which have been long raised from sets or tubers?*

The answers to this inquiry are numerous. Nearly all the Reporters state, that potatoes raised recently from seeds were equally subject to the disease as those which had been long propagated from the tubers; and, in the opinion of many of the Reporters, the potatoes recently raised from seeds were more liable to be affected than the others. Statements upon this point will be found in the following Reports:—

Mr John Hutchison, Aberdeenshire,	-	-	No. 1
Mr W. F. Campbell, Argyleshire,	-	-	— 8
Mr William Kennedy, do.,	-	-	— 16
Mr James M'Innes, do.,	-	-	— 18
Mr John Lade, Ayrshire,	-	-	— 23
Mr John Findlay, do.,	-	-	— 28
Mr James M'Kelvie, do.,	-	-	— 29
Mr Alexander M'Caw, do.,	-	-	— 30
Mr Thomas Brown, do.,	-	-	— 32
Mr John Wilson, Berwickshire,	-	-	— 33
Mr George Darling, do.,	-	-	— 34
Dr J. L. Russell, Dumfries-shire,	-	-	— 48
Mr Alexander Tod, Edinburghshire,	-	-	— 55
Mr Alexander Scott, do.,	-	-	— 57
Mr John Girdwood, do.,	-	-	— 59
Mr John Finnie, do.,	-	-	— 63
Mr John Dickson, do.,	-	-	— 64
Sir John S. Richardson, Perthshire,	-	-	— 108
Sir David Dundas, do.,	-	-	— 109
Mr Robert Boyd, Peebles-shire,	-	-	— 111
Mr William Glen, Renfrewshire,	-	-	— 112
Mr A. F. Gardner, do.,	-	-	— 117
Sir James Russell, Selkirkshire,	-	-	— 128

All these reports concur as to the fact, that potatoes from seeds were as bad as, or worse than, others. The contrary opinion is reported by only three gentlemen, namely—

Mr John Hogarth, Berwickshire, No. 35, who states, that some raised from seed were free from disease and kept well.

Mr Alexander J. Main, Edinburghshire, No. 65, who says that sets of potatoes, raised for four years from seed, were not so much affected as those from older tubers.

Mr Francis M'Minn, Lanarkshire, No. 94, who mentions that the only potatoes raised from seed in his neighbourhood have kept.

By some it is mentioned that the oldest and apparently the most deteriorated kinds suffered less than the new and recently imported varieties.

Mr Campbell of Islay, No. 8, says, that those cultivated for a long period in the island of Islay were better than those recently raised from seed.

The very extensive experiments in raising from seed, for which the Society's medal was awarded to Sir James M. Riddel's overseer, established the tendency to disease of those so produced, as will be seen from the report of Mr William Kennedy, No. 16, Argyleshire.

A case is mentioned by Mr Angus Ross at Stonebyres in Lanarkshire, No. 92, in which the potatoes grown in one spot, upwards of 30 years, escaped amid the general destruction of new varieties, the latter being well and properly stored, while the other had no such advantage.

Mr Gorrie, Perthshire, No. 105, alludes to the Perthshire Red in a deteriorated state as being, on the same land, less affected than the newly imported and vigorous Peruvian Kidney.

Mr Boyd, Peebles-shire, No. 111, cites cases where the same sorts have, for 40 years in succession, been raised by the shepherds, and still are good.

3d. *Whether any particular condition of the soil as to wetness, pre-*

vious cultivation, or the kinds of manures used, appear to have had any influence in promoting, retarding, or preventing, the disease?

The Reports received, in answer to this part of the inquiry, do not show that any particular condition of the soil as to wetness, previous culture, or kinds of manure employed, produced an exemption from the disease; and the mass of the evidence goes to establish the fact, that the progress and extent of the disease were but little influenced either by the nature of the soil, the previous culture, or the kinds of manure.

1. *Soil.*—While no cases have been reported in which rich, low-lying, or damp, heavy soils were most free from the disease, there are many in which the crops on such soils were the most liable to be attacked. The following parties concur in remarking, that the crops grown on clay, or rich heavy loam, suffered more than those grown on light, gravelly, or sandy upland districts:—

Mr John J. Burnett, Ayrshire,	No. 21
Mr George Darling, Berwickshire,	— 34
Mr John Paterson, Arran,	— 37
Mr D. Montgomery, Dumbartonshire,	— 44
Mr Alexander Stevenson, Dumfries-shire,	— 46
Messrs Young, Fifeshire,	— 69
Mr James Falconer, Kincardineshire,	— 82
Mr David Tennant, Kirkcudbright,	— 88
Mr George Whittit, jun, Linlithgowshire,	— 95
Mr Archibald Gorrie, Perthshire,	— 105
Sir John S. Richardson, do.,	— 108
Mr A. F. Gardner, Renfrewshire,	— 117

That the disease was not dependent upon, or controlled by, any peculiar condition or nature of soil, is the opinion of the following gentlemen:—

Captain Alexander Montgomerie, Ayrshire,	No. 22
Mr John Findlay, do,	— 28
Mr John Wilson, Berwickshire,	— 33
Mr James Johnston, Dumbartonshire,	— 42
Mr Robert Elliott, Dumfries-shire,	— 45
Dr J. L. Russell, do.,	— 48
Mr Alexander Scott, Edinburghshire,	— 57
Mr John Girdwood, do.,	— 59
Mr John Finnie, do.,	— 63
Mr John Dickson, do.,	— 64
Mr Alexander J. Main, do.,	— 65
Mr P. Hume, Fifeshire,	— 66
Mr James Kerr, do.	— 68
Mr James Bruce, Haddingtonshire,	— 73
Mr Andrew Douie, Kinross-shire,	— 86
Mr Francis Maxwell, Kirkcudbright,	— 89
Mr North Dalrymple, Lanarkshire,	— 93
Mr Francis M'Minn, do.,	— 94
Mr William Glen, Renfrewshire,	— 112
Col. D. H Macdowall, do.,	— 116
Mr John Dudgeon, Roxburghshire,	— 122

But some of the Reporters above-mentioned refer to a partial exemption in the case of deep peaty soils or moss; while the following report distinctly, either that there was no disease on moss, or that the crops were affected in a much less degree than on other kinds of soil:—

Mr Gavin Dunlop, Aberdeenshire	- -	No. 4
Dr D. Macfarlane, Argyleshire,	- - - -	— 7
Mr Dugald M'Dougall, do.,	- - - -	— 11
Mr Colin Campbell, do,	- - - -	— 14
Mr William Kennedy, do.,	- - - -	— 16
Mr Samuel Mitchell, do.,	- - - -	— 20
Mr Robert Hewitson, Dumfries-shire,	- -	— 47
Mr James Bruce, Haddingtonshire,	- -	— 73
Mr Robert Walker, Kincardineshire.	- -	— 78
Mr Andrew Douie, Kinross-shire,	- -	— 86
Mr William Ewing, Perthshire,	- - -	— 106
Mr James Cousin, do.,	- - -	— 107
Sir John S. Richardson, do,	- - -	— 108
Mr Allan Pollok, jun., Renfrewshire,	- -	— 118
Mr William Ogilvie, Roxburghshire,	- -	— 120

The following merely state that there was less of the disease on moss than on any other kind of land:—

Mr W. F. Campbell, Argyleshire,	- -	No. 8
Mr James M'Innes, do.,	- - -	— 18
Mr James M'Kelvie, Ayrshire,	- -	— 29
Mr John Paterson, Arran,	- - -	— 37
Dr J. L. Russell, Dumfries-shire.	- -	— 48
Mr David Don, Fifeshire,	- - -	— 67
Sir David Dundas, Perthshire,	- - -	— 109
Mr A F. Gardner, Renfrewshire,	- -	— 117
Mr Peter Blackburn, Stirlingshire,	- -	— 126

Mr Andrew Douie, factor at Blair Adam, Kinross-shire, No. 86, mentions the case of a furrow-drained field which had not been under potatoes for 20 years, and in which the entire crop was tainted, with the exception of what was grown on a stripe of moss by which the field was intersected.

Mr Robert Hewitson, Auchinbenzie, Dumfries-shire, No. 47, states, that of two fields cultivated alike, and for the first time under potatoes, the one a dry soil, was extensively affected, while the other, a mossy one, was free.

Amid all the returns there is but one instance of the disease having been found more virulent in moss land than elsewhere.

Mr Campbell of Auchinbreck, Argyleshire, No. 19, states, that his crop suffered most in a field with a southerly exposure, and he attributes this to the peaty nature of the soil. But this solitary case is in opposition to the numerous cases recorded of a contrary nature, and may be supposed to have arisen from some other cause than from the soil being peaty.

Potatoes were planted by some on land which had never borne them before, or which had been broken up from old pasture. There are only two Reports, those of

Mr David Syme, Kinross, No. 85, and Mr George W. Hay, Whiterigg, Roxburghshire, No. 119, in which it is stated that any advantage was thereby gained. It should also be remarked in reference to the first of these cases, that the sound crop in the newly brought in land had received no manure, while that which suffered in the old land had been heavily manured in the ordinary manner.

That the disease was as prevalent on land where potatoes were grown for the first time as in older cultivated ground, is stated

Mr John Clerk, Argyleshire, - - -	No. 9
Mr John Findlay, Ayrshire, - - -	— 28
Mr Alexander M'Caw, do., - - -	— 30
Mr William M'Clive, do., - - -	— 31
Mr William Wallace, Dumbartonshire, - -	— 43
Mr Robert Hewitson, Dumfries-shire, - -	— 47
Mr John Finnie, Edinburghshire, - -	— 63
Mr John Dinwoodie, Wigtonshire, - -	— 132

As low-lying grounds suffered more than elevated situations, some of the Reporters infer that the want of a free circulation of air was prejudicial; as in the cases mentioned by

Mr Samuel Mitchell, Argyleshire, - -	No. 20
Mr Alexander Scott, Edinburghshire, - -	— 57

On the other hand, Mr William Rutherford, No. 15, and Mr James M'Innes, No. 18, both Argyleshire, report that the plants sheltered comparatively escaped.

Mr W. F. Campbell, Argyleshire, - -	No. 8
Mr Richard Campbell, do., - -	— 19
Mr D. Montgomery, Dumbartonshire - -	— 44
Mr James Cousin, Perthshire, - -	— 07

Report that fields with a northern exposure were the least affected, while Mr John Finnie, Edinburghshire, No. 63, states that a field so exposed was the worst. He adds, however, that from circumstances it did not dry so readily as other portions of his farm. Mr Montgomery, gardener to the Duke of Montrose, Dumbartonshire, No. 44, mentions, that on two farms occupying, the one the north, the other the south side of a hill, the potatoes on the first were sound, on the second all unsound; the soil, cultivation, and variety planted, being in both cases the same.

2. *Previous Cultivation.*—With respect to the effects of previous cultivation, the following parties state that the higher the cultivation, and the heavier the crop, the more extensively was it affected:—

Mr Alexander Gordon, Argyleshire, - -	No. 12
Mr John J. Burnett, Ayrshire, - - -	— 21
Mr John Lade, do., - - -	— 23
Mr D. Cuninghame, do., - - -	— 24
Mr D. Montgomery, Dumbartonshire, - -	— 44
Messrs Young, Fifeshire, - - -	— 69
Mr George Whittit, junior, Linlithgowshire, -	— 95
Mr William Glen, Renfrewshire, - -	— 112
Mr John Brock, senior, do., - - -	— 115
Mr A. F. Gardner, do., - - -	— 117

3. *Manures.*—With respect to the effect of manures, it does not appear from the Reports that the disease was more influenced by the particular kinds of manure than it was by difference of soil.

Where manure had been applied in the largest quantity, the disease was observed to be most prevalent by

Mr Gavin Dunlop, Aberdeenshire, - - -	No. 4
Mr Alexander Gordon, Argyleshire, - - -	— 12

Mr William Kennedy, Argyleshire,	No. 16
Mr Alexander M'Caw, Ayrshire,	— 30
Mr A. F. Gardner, Renfrewshire,	— 117
Dr D. Macfarlane, Argyleshire, who remarks that it was worst where the dung heaps had been laid on the field,	— 7
Mr Alexander M'Caw, Ayrshire, who states that the only escape was in a few drills where there happened accidentally to be no manure, the crop being poor but sound,	— 30

The following reporters refer to experiments with different kinds of manures:—

Mr John J. Burnett, Ayrshire, and	— 21
Mr A. F. Gardner, Renfrewshire, recommend saline preparations,	— 117
Mr James Bruce, Haddingtonshire, found no benefit to result from them,	— 73
Mr William Kennedy, Argyleshire, prefers guano to farm-yard manure,	— 16
Mr James Johnstone, Dumbartonshire, found guano-raised potatoes to be the most affected,	— 42
Mr Gavin Dunlop, Aberdeenshire, makes a similar statement,	— 4
Mr William Kennedy, Argyleshire,	— 16
Mr Dugald M'Dougall, do., and	— 11
Mr A. K. M'Kinnon, Skye, found sea-ware better than ordinary manure,	— 75
Mr John Clerk, Argyleshire, found it to be worse,	— 9

Others attribute importance to the manner in which the manure is prepared and applied. But the great mass of authority goes to establish that no modification of the disease was observed to result from the condition or kind of manure, and that it manifested itself to an equal extent, and with equal virulence, under all applications, whether of common manures, or of what have been called special manures; and it is important to keep in mind that statements to this effect have been communicated by some of the most experienced practical farmers in the country, who are in the habit of making an extensive use of manures of every kind. The following are the names of the parties who experienced no result from difference of manure.

Dr D. Macfarlane, Argyleshire,		No. 7
Mr William Rutherford, do.,		— 15
Captain Alexander Montgomerie, Ayrshire,		— 22
Mr James Paterson,	do.,	— 27
Mr John Findlay,	do.,	— 28
Dr J. L. Russell, Dumfries-shire,		— 48
Mr Alexander Tod, Edinburghshire,		— 55
Mr Alexander Scott,	do.,	— 57
Mr John Girdwood.	do.,	— 59
Mr A. F. Allan,	do.,	— 61
Mr John Finnie,	do.,	— 63
Mr John Dickson,	do.,	— 64
Mr Alexander J. Main,	do.,	— 65
Mr James Bruce, Hadingtonshire,		— 73
Mr James Falconer, Kincardineshire,		— 82
Mr Andrew Douie, Kinross-shire,		— 86
Mr David Tennant, Kirkcudbright,		— 88

Mr Francis Maxwell, Kirkcudbright, - -	No. 89
Mr North Dalrymple, Lanarkshire, - -	— 93
Mr Francis M'Minn, do., - - -	— 94
Mr James Cousin, Perthshire, - - -	— 107
Sir John S. Richardson, do., - - -	— 108
Sir David Dundas, do., - - -	— 109
Mr Robert Boyd, Peebles-shire, - -	— 111

These various communications may be said to exhaust the subjects of inquiry under Query second; but there are other circumstances connected with the general treatment of the diseased plant which merit consideration.

Mr Scott, Craiglockhart, Edinburghshire, No. 57, observes, that potatoes, the stems of which were affected by curl, were less liable to the disease than others; and this is corroborated by Mr Bertram, Smeaton, No. 62, one portion of whose crop was curled, and which, though very poor in bulk, was quite sound, and kept so during the season.

Mr Alexander M'Caw, Ayrshire, No. 30, reports, that the tubers nearest the stem were the worst; that whenever the stem was affected the tuber was so likewise; and that when a tuber was sound, the upper part only of the connecting fibril showed symptoms of disease. He states likewise, that the only sound portion of his crop was that in which there was very little stem.

Sir John S. Richardson, Perthshire, No. 108, remarks, that where the stems were rank, the disease was worst. The same statement is made by Mr James Buchie, Stirlingshire, No. 125; and it is a very general observation, that the more luxuriant the appearance of the crop, the more tainted it generally was.

These remarks bear upon a question which has been much agitated, whether the disease may not be retarded by checking the growth of the stem and foliage.

The following gentlemen concur in stating, that wherever the stems were early blackened or killed by frost, these were afterwards found to be the least diseased.

Mr James M'Kelvie, Ayrshire, . .	No. 20
Mr Peter Algie, Renfrewshire, . .	— 114
Mr Allan Pollok, junior, do., . .	— 118

Mr Russell, Secretary to the Trafalgar Agricultural Society, Fifeshire, No. 71, cites several cases, tending to show that the destruction of the stems by early frosts prevented the disease.

There are but three cases reported in which the stems were removed, and in each of them the result was similar.

Mr Brown of Lanfine, Ayrshire, No. 32, refers especially to a case of this kind, and Sir John Richardson, No. 108, states, that in Perthshire, the only sound potatoes observed by him were some of his own, in which the stems had been pulled, and others belonging to a cottager who had cut them for his cow.

The communication by Mr Gardner, No. 117, overseer at Barochan in Renfrewshire, although different in detail, is to the same effect, and tends to support the opinion that the disease may be influenced when the connexion between the stem and the tubers has been disturbed.

Several of the reporters refer to the benefit as affecting the disease of lifting the crops at an early period; as in the cases mentioned by

Mr Charles Stirling, Stirlingshire, No. 127, and by Mr Hope Smith, Berwickshire, No. 36; and in support of the same opinion are the cases mentioned by Mr Scott, Edinburghshire, No. 57, and Mr Dickson, Edinburghshire, No. 64, in which, when fields that had borne potatoes were afterwards ploughed for wheat, it was observed that while in the parts where the potatoes were late in being removed, any tubers accidentally left on the ground were diseased, those left in the early lifted portions continued to be sound and free from taint.

In these cases it would seem that lifting potatoes before the disease had advanced to a certain stage was often the means of preserving the crop; and, in support of the same view, cases are mentioned in which late planted potatoes, and which, on that account, probably did not reach the same state of maturity as those planted early, escaped.

Query Third.

What have been the modes employed in storing the potatoes, and what are the means which have been found most successful in preserving the healthy tubers, and preventing the extension of the taint from the diseased to the sound ones?

It may be observed with respect to the latter part of the question, that the Reports are almost all adverse to the opinion that the taint is apt to extend from the diseased to the sound tubers after they are taken from the ground. There are repeated statements of good and bad tubers having been observed in the same heap, and even of healthy tubers having been found in the midst of a mass of rotten ones; and experiments are recorded of cutting and tying together portions of sound and unsound tubers without the former having been infected. Statements corroborative of these views will be found in the reports of

Dr D. Macfarlane, Argyleshire, - - -	No. 7
Mr William Rutherford, do., - - -	— 15
Mr D. Cuninghame, Ayrshire, - - -	— 24
Mr John Girdwood, Edinburghshire, - -	— 59
Lord Arbuthnot, Kincardineshire, - -	— 79
Sir John S. Richardson, Perthshire, - -	— 106
Mr A. F. Gardiner, Renfrewshire, - -	— 117

Mr Gorrie, Perthshire, No. 105, indeed, records an experiment which would seem to lead to a different conclusion. He joined the half of a diseased potato to that of a sound one, and in the course of a week he found the disease to have made such progress that the sound half showed, to the depth of an eighth of an inch, the exact impress of the diseased portion. This experiment, however, it is manifest, cannot be regarded as conclusive. There are several other cases

reported, and among them one by Mr Gorrie himself, with a different result; and it must be kept in mind that one case of escape goes further to disprove contagion, as it may be called, than several instances of a contrary nature to establish it, since we cannot be assured that the apparently sound portion had not already in itself the germs of the disease, and might not have exhibited similar symptoms though unconnected with that which was visibly affected.

Mr John Dinwoodie, Wigtonshire, No. 132, by way of experiment, placed a stone weight of healthy potatoes in a heap which was perfectly rotten, and found them unchanged at the end of a month.

With respect to the modes adopted in storing the potatoes, much useful information is communicated, though it will be observed that the reporters do not all concur in opinion as to the benefits of particular modes of practice.

There are several gentlemen who report that the disease defied every precaution, and that no mode of storing exercised any influence over its progress. Others conceive that the efforts made for preservation by adopting peculiar modes of storing, were more or less successful in arresting the decay of the tubers. Whatever opinion may be formed on this point, there cannot be a question that, whether the potatoes be sound or unsound, every proper means ought to be employed to store them in the best condition, and in a proper manner.

Several reporters refer to the practice of permitting the potatoes to remain in the ground, and covering them deeply with earth by the plough. Statements with respect to this mode of preservation will be found under the following heads:—

Mr Alex. L. Finlay, Argyleshire, - -	No. 6
Mr Alex. Gordon, do., - - -	— 12
Mr William Kennedy, do., - - -	— 16
Mr James M'Innes, do., - - -	— 18
Mr Richard Campbell, do., - - -	— 19
Captain Alex. Montgomerie, Ayrshire, - -	— 22
Mr Alex. M'Caw, do., - -	— 30
Mr Thomas Brown, do., - -	— 32
Mr John Wilson, Berwickshire, - - -	— 33
Mr D. Montgomery, Dumbartonshire, - -	— 44
Dr J. L. Russell, Dumfries-shire, - -	— 48
Mr Alex. J. Main, Edinburghshire, - -	— 65
Mr David Don, Fifeshire, - - -	— 67
Mr Andrew Howden, Haddingtonshire, - -	— 74
Mr Robert Findlay, Lanarkshire, -	— 90
Mr Angus Ross, do., - -	— 92
Mr Francis M'Minn, do., - -	— 94
Mr James Cousin, do., - - -	— 107
Mr Robert Boyd, Peebles-shire, - -	— 111
Mr Allan Pollok, jun., Renfrewshire, - -	— 118
Mr Robert Nisbet, Roxburghshire, - -	— 121
Mr John Dudgeon, do., - -	— 122
Mr James Buckie, Stirlingshire, - - -	— 125
Mr John Dinwoodie, Wigtonshire, - -	— 132

But whatever advantages may, in certain cases, have been

found from leaving the potatoes in the ground, it is manifest that it can never become a practice on the farms of this country, since the due preparation of the ground for the ensuing crops must be generally held to be of more importance than the probable benefit to the potato crop from the practice.

Reference must be made to the Appendix for the particular modes of storing pursued or recommended by the different reporters. In general it will be seen that they concur in recommending that the stores or heaps shall be of small or moderate size, and that they shall not be too heavily loaded with earth; and many of them suggest ventilation by means of tiles or otherwise. Few appear to have found any benefit from mixing lime with the heaps, and some conceive the practice to be injurious. Neither is it established that mixing other substances with the potatoes in the heaps is beneficial, or superior to the practice confirmed by long experience of storing the potatoes alone, dry and in good condition.

In some of the reports will be found statements indicative of the opinion of the writers, that the heaps should not be too heavily loaded with earth, at least at first.

Mr Elliot, Hardgrave, Dumfries-shire, No. 45, states, that he had his potatoes covered with straw, but that during a high wind some shovelfuls of earth were placed upon the straw, and that in a few days the disease appeared beneath the earth, but was arrested in its further progress when the earth was removed.

Mr Scott, Craiglockhart, Edinburghshire, No. 57, states that pits, though carefully ventilated, yet if covered with earth, did not answer, while, when covered with straw, they did.

Mr Vallentine, Secretary to the Fettercairn Agricultural Society, Kincardineshire, No. 84, put on a covering of straw or turf at night, which for eight or ten days was removed every morning.

Ventilation of the heap is recommended by many of the Reporters, some effecting it by means of spars or branches of trees or thorns, but most by means of common drain tiles. Statements to this effect will be found in the reports of

Mr Alexander Tod, Edinburghshire, - -	No. 55
Mr John Girdwood, do., - - -	— 59
Colonel Briggs, Fifeshire, - - -	— 70

Some, however, do not approve of ventilation, as—

Mr Alexander Gordon, Argyleshire, - -	— 12
Mr Andrew Douie, Kinross-shire, - -	— 86

Mr Douie cites a case in which, in his opinion, ventilation was very prejudicial; and the practice certainly requires to be adopted with great caution, since, by admitting the external air in severe frosts, the potatoes might be seriously injured even though free from disease.

Storing in houses is approved of by

Mr William M'Clive, Ayrshire, - - -	No. 31
Mr Robert Elliot, Dumfries-shire, - -	— 45
Mr John Steven, Edinburghshire, - -	— 60

Mr P. Hume, Fifeshire, - - - -	No. 66
Mr James Falconer, Kincardineshire, - -	— 82
Mr James Farquharson, do. - - -	— 83
Sir David Dundas, Perthshire, - - -	— 109
Mr Robert Nisbet, Roxburghshire, - -	— 121

And disapproved of by

Mr Thomas Brown, Ayrshire, - - -	— 32
Mr Alexander Scott, Edinburghshire, - -	— 57
Mr John Girdwood, do. - - -	— 59
Sir Ralph Anstruther, Fifeshire, - -	— 72

Turning and handpicking are recommended by some, but condemned by others. Several parties decidedly object to turning potatoes deposited in stores, conceiving that the operation may have the effect of promoting the tendency to decomposition.

No support is given to the opinion, that any advantage results from artificial drying of the tubers by the kiln or otherwise. The practice is distinctly condemned by

Mr Campbell, of Islay, Argyleshire, - -	No. 8
Mr Brown, of Lanfine, Ayrshire, - -	— 32
Mr P. Hume, Fordel, Fifeshire, - -	— 66
Mr Andrew Buchan, Hayston, Peebles-shire, -	— 110

Numerous statements are given of experiments with various mixtures with the stored potatoes, as sand and lime, peat-dust, moist peat, moist charcoal, coal-ashes, burnt gypsum, &c. The details will be found in the Appendix. The greater number of the experiments seem to have been made with lime. The following gentlemen recommend dusting or sprinkling with lime,—

Mr Allan M'Dougall, Argyleshire, - -	No. 10
Mr John J. Burnett, Ayrshire, - - -	— 21
Mr D. Montgomery, Dumbartonshire, - -	— 44
Messrs Young, Fifeshire, - - -	— 69
Colonel D. H. Macdowall, Renfrewshire, -	— 116

The following, on the other hand, report either that lime had no beneficial effect in checking the progress of the disease, or that the potatoes amongst which it was mixed were injured by the application.

Mr Alexander Gordon, Argyleshire, - -	No. 12
Mr William Kennedy, do., - -	— 16
Mr James Paterson, Ayrshire, - - -	— 27
Mr Alexander M'Caw, do., - - -	— 30
Mr William Wallace, Dumbartonshire, - -	— 43
Mr Alexander Scott, Edinburghshire, - -	— 57
Mr John Girdwood, do., - - -	— 59
Mr Francis Maxwell, Kirkcudbright, - -	— 89
Mr Francis M'Minn, Lanarkshire, - -	— 94
Mr James Cousin, Perthshire, - - -	— 107
Sir David Dundas, do., - - -	— 109
Mr A. F. Gardiner, Renfrewshire, - -	— 117
Mr Allan Pollok, jun. do., - - -	— 118

This formidable disease having reappeared in the present season with aggravated symptoms, and far more extensively than before, it is a question of considerable interest how far it may be regarded as a sudden visitation, or how far it has been progressively extending. In the former case we might entertain a reasonable hope that it might disappear as quickly as it has come. In the other case we should have more reason to apprehend that we cannot for the future depend upon this plant, in the same degree as hitherto, for any considerable part of the food of the inhabitants of this country. The fact of its appearance several years ago is referred to in the Society's printed paper, and several of the reporters give good reason to believe that it is not so new as it has been supposed to be.

Dr Lachlan M'Lean, Argyleshire, No. 13, describes a disease which attacked the potato crop of the Hebrides about twelve years ago, and which, from the symptoms and effects, was manifestly the same as that which now prevails.

Mr Burnett, Gadgirth, No. 21, and Captain Montgomerie, Bridgend, No. 22, state that it is not new in the county of Ayr. Mr Burnett says, that a considerable part of the crop in Ayrshire was lost by it in 1844, but that the attack being partial, the disease was not sufficiently investigated, while in many cases its existence was concealed by farmers in order that the character of their farm-produce might not be affected.

Mr Alexander M'Caw, Ardlochan, Ayrshire, No. 30, details the circumstance of its appearance in 1844, while the case so minutely described by Mr Brown, of Lanfine, No. 32, must, with those above alluded to, conclusively establish the fact that, in Ayrshire at least, this disease existed to a considerable extent in 1844.

It is scarcely necessary to observe, that no satisfactory explanation of the predisposing causes of this destructive disease has yet been given, and that, of the theories promulgated on the subject, none seems calculated to lead to a practicable remedy.

Many have ascribed the disease of last year to the low temperature and excessive rains of the season, but it may be now held to be ascertained that the disease had appeared in these Islands in favourable seasons, and extensively in parts of North America, where the summers are always warm; and the experience of the present year has shown that the disease may take place in a season when the temperature is high, and the weather otherwise eminently favourable to the growth of tuberous-rooted plants. We cannot, therefore, be assured that even in the most favourable seasons the disease may not re-appear with symptoms as aggravated as at present.

It is an almost universal opinion that the disease first appears in the stems and foliage, where it is indicated by the growth of certain fungi; but the experience of the present year will perhaps lead us rather to the conclusion that the disease is deeper seated, and first appears in the root. On examining the growing plants,

the principal root or tap-root, it is believed, will always be seen to be affected, and this often before any symptoms indicative of it have appeared in the stems and foliage. The taint will be seen extending along the connecting rootlets to the tubers, and this while the stems and leaves are growing luxuriantly, and are free from any perceptible taint, when all at once, on the disease reaching the part of the plant above ground, the leaves exhibit the symptoms now so well known. If it shall turn out that the disease first appears in the root, we can scarcely expect that many of the remedies proposed, as sprinkling the growing plants with lime or other substances, will be of use; and it will then also be probable that the cutting over of the stems acts only as a palliative by arresting the progress of vegetation.

REPORT ON THE POTATO DISEASE—APPENDIX.

ABERDEENSHIRE.

No. 1.—Mr John Hutchison. Monyruy, 21st March 1846.

It is about eight years ago, since which there has been a great failure in the potatoes in this quarter (as in many others,) that I took it into my head, it was owing to the potato having been planted so long from tubers, and I set about raising them from seed; I succeeded in raising a very great variety, but selected one I considered far superior to the others, and got a stock from it. I should here mention, that being anxious to get a stock as fast as possible, I had forced them with rather more dung than usual. When I had raised my stock from the seed to more than I wanted for myself for seed, I was of course anxious that my neighbours should have the advantage of these (as I thought) *sure seed potatoes*, and gave to many about me. You may guess my disappointment when that year, that very seed proved the worst, and had more failures from them than from any I had ever before or since, nearly one-third never having come up. I have recollected since, that the year they were produced they had an unusual quantity of potato plums upon them, and also that many had the appearance of a dry mould on them when taken out of the pit to plant, there being also a few slight black or brown marks to be seen on the skin of the potatoes. The produce of the potatoes that *did* grow have been grown every year since, (some four years,) and have never been so bad again, and indeed only one year since have there been any failures to speak of.

Now in this district of Buchan there was no appearance of disease whatever in the growing potatoes of last season, nor at the time of taking up; but from the great alarm there has been about the disease, the pits have been all most narrowly inspected, and a few potatoes in *every* pit were found to have the black marks under the skin, and also some were found to show a little mouldy appearance about the eye—but the pits in general were fully sounder than they have been for years past, *although no pit is declared free of the disease.* Can this be the disease that is prevalent in the south? The same has existed here for years—and I should certainly say is not getting worse, or, if so, very slowly. I feel satisfied these remarks will apply to all the district of Buchan; for being a buyer of potatoes for seed to send to the south, I have inspected a number of pits in the district.

I have an idea that the disease here is connected with the planting the potatoes *on the dung*, and perhaps the hasty plan of pitting them. I am trying now to grow my potatoes for seed on poor land, without dung; and to take care to ventilate the pits.

No. 2.—Mr Hugh M'Connach. Bridge of Alford, 24th March 1846.

The Anniversay Meeting of the Vale of Alford Agricultural Association was held here this day—Mr Taylor, Wellhouse, in the the chair—*Inter alia*, a communication from the Highland and Agricultural Society of Scotland was given in and read, relative to the potato disease. The meeting is happy to find that no such disease is known in this part of the country.

No. 3.—General Byres. Tonley, 26th March 1846.

Yours dated the 9th of this month I duly received, and circulated the enclosed to the farmers of Alford; and have received a general report from them, that their potatoes are fully as good this season, as they have been some years past, and no disease at present has appeared to injure the potato; and I am assured by many

of the farmers, that they have examined them very lately in their pits, and found them perfectly sound and healthy, and disposing of them for seed at 16s. and 20s. per boll. They have generally stored them in the usual way—heaped up in pits covered with mould. Part of my own I left in the drills all winter, and examined them a few days ago, and I found them quite free from disease, and healthy. The round red potato is generally cultivated in this part of the country for *home consumption*, and no various means, in any way, for securing the crop, has been used, as the farmers did not find it was required. I am of opinion that potatoes lying long in wet *clay* soil, and not exposed to the air, will be diseased, also potatoes planted in rich *close* (farm-yard) dung. The above is all the information I have been able to collect respecting the potato crop in this part of the country.

No. 4.—Mr Gavin Dunlop. Rosehearty, 26th March 1846.

1st, The disease affecting the potato crop did not appear in this district when the plant was growing; on the contrary, it seemed as healthy, and flourished as well as in any former season; and no fear was apprehended when the potatoes were lifted, there being no mark of disease to be seen.

2d, The round red potato appears to have resisted the disease better than any other kind planted in this district—which are dons, blue and buff. Potatoes grown on moss land appear most sound. Such as were grown on clay are certainly the worst. Such lands as got the greatest portion of manure, such as guano and fish offal, have suffered most. The writer had 200 bolls grown from these manures, the one-half of which is lost for human food.

3d, The disease did not appear in this district sooner than the first week of November, and at that time only partially, my own being the first. When lifted, they appeared perfectly sound, and were pitted in fine condition. When the pits were opened, first week of November, found the one-half to be much affected with the disease. I immediately turned the whole over, selected the good from the bad. I turned them over two or three times, covered them again with turf, put no earth on, and the disease made no farther progress. Had the potatoes in this district not been covered up with earth, but remained with the turf, they would have escaped. Ventilation being of great benefit, if such as grow potatoes would cover them with turf, they might prevent much damage; and should frost afterwards appear, a little earth might then be thrown over the turf.

No. 5.—Mr Peter Paton. Fraserburgh, 27th March 1846.

In answer to the first point of inquiry, as to what period in the season a discovery of disease in the potato crop of last year manifested itself, I can speak of the Fraserburgh district only, having had no opportunity of witnessing any other. It never occurred to the growers of potatoes in this district, that any thing was the matter with their crop, till about the 1st of February, when the English dealers raised a clamour about taint or murrain being general throughout the length and breadth of the land, and that the whole of the potato crop of last year would be lost. Curiosity then led the growers to examine their pits, and they discovered the hue and cry to be a hoax on the farmers, to induce them to sell their supposed damaged potatoes at reduced prices from what was offered previously by the agents for the Yorkshire farmers, and in many instances accepted of by the farmers here. The game was too successful, the farmers took fright, and the district is the loser to the extent, I may safely say, of £2000 sterling, while the potatoes are daily shipping here in the same good order as in former years. The quantity that will be exported from this district will exceed 8000 tons.

Few varieties of potatoes are cultivated in this district, for exportation. The round reds are the prevailing kind, and, in my opinion, they are perfectly free

from disease of any kind. It is not to my knowledge that any individual in this district has been successful in introducing potatoes recently obtained from seeds. The reds were introduced here about twenty years ago, and are the most vigorous, healthy, and prolific that we have any experience of. A variety called Dons, or London droppers, were getting into fashion, and as the last crop exhibited symptoms of disease, they will not be much persevered with, as an article for export, although they may be planted in gardens, on a small scale, being an earlier variety. Some years ago, the potato crop was subject to dry-rot after planting; and more attention was afterwards bestowed upon the preparation of the ground for their reception, by having it earlier prepared, and the dung properly fermented, before an attempt was made to open the drills for the manure and the seed; and greater activity used in manuring and planting, ere the natural moisture of the soil could be extracted by the influence of drought, or the heat of the sun. All small potatoes, about an inch in diameter, are planted whole, while the cut seed is previously mixed with moist ashes, and in some cases with lime, for eight or ten days, to heal the bleeding wound of the cut potatoe. Short manure, to the extent of half a dunging, with two or three hundred weight of guano to the acre, is highly approved of. Since the above precautions were introduced, neither short-coming of crop nor disease has appeared in the round red potatoes; and as to the manner of storing, they are put into long narrow pits, say 5 feet wide at the bottom, then covered with turf or thatch, before being covered with earth, to the depth of 6 or 8 inches. If there is a little earth mixed through the pit, so much the better. Sometimes apertures or crevices appear in the pits, but they should be immediately filled up.

ARGYLESHIRE.

No. 6.—Mr Alex. L. Findlay of Castle Toward. Greenock, 14th March 1846.

1st, I believe the disease in the potatoes I had (about 4 acres) began in August or September, but only to a very limited extent, and not enough to give me any alarm. The stems and leaves decayed sooner than usual, but showed no other symptom of disease—which was not apparent in any great degree, until the potatoes had been ten days in the pit. The pits were closed about the 12th October, and re-opened on the 23d, when more than one half were quite rotten—a mere mass of putrefaction, emitting a very offensive odour. They were quite useless, and were put back into the pit, and covered with earth, to rot.

2d, We had two kinds of potatoes, the red and cups, both of which suffered pretty much alike.

3d, The potatoes which suffered so much were stored in pits of the usual size, on the field, in a dry situation. I, however, left about an acre in the ground, and, in November, lifted every alternate row (to enable us to cover up those which remained.) The potatoes which were then dug, were put into pits, formed by two rows of stabs and rafters, 3 feet apart, and about 2 feet high; between these the potatoes were thrown, and then covered with straw and earth. The inside of the stabs and rafters were lined with branches of trees and straw, to keep out the frost, but sufficiently open to allow a current of air to pass through. In this manner, they kept well. Some are still in the ground, and, so far as I can judge, the disease has made no progress amongst them since November. I tried lime and coal-ashes, but am of opinion that the preservation of potatoes depends very much upon their being kept dry, and exposed to a free current of air—all the diseased ones being of course removed.

I may add, that many potatoes, almost entirely rotten, are now throwing out vigorous shoots. I have planted one in the garden, to ascertain if the produce will be sound.

No. 7.—Dr D. MACFARLANE, Dalilougart. Dunoon, 16th March 1846.

I first observed the leaves of my potatoes becoming affected from the 20th to the end of September; the leaves of those varieties which I afterwards found to have suffered most, being earliest and most severely blighted. To the eye the appearance was very much the same as blight from frost.

I had four varieties growing on a field newly reclaimed out of moss and moorland, by trenching, draining, and liming. 1st, Black seedling, recently imported from Ireland—about one-fifth of the tubers diseased. 2d, A white variety slightly streaked with pink—about a sixth part affected. 3d, The old Highland white, usually reckoned very hardy and productive—fully one-half of this sort was tainted. Fortunately, the greater part of my potatoes were cups, and they comparatively escaped, especially on the mossy part of the field; not above a twelfth or thirteenth part of them suffered. I used several kinds of manure—stable-yard dung, guano (African), Potter's British guano, top dressing with animal charcoal, guano and common salt, but did not observe any difference in the effects with regard to the disease. Those portions of the field, indeed, on which the dung heaps had been laid were very much affected.

I used no particular precaution in pitting my potatoes, and they have kept remarkably well, especially the cups. My pits were narrow, about 5 cwt. to a yard in length, placed on the surface and covered with a layer of straw, and about 7 or 8 inches of dry earth. I did not dig my potatoes until they were thoroughly ripe—not until November, and some in December. I never turned them in the pits, so as to separate the sound from the unsound, and they are now as healthy and fresh as they were when pitted. The diseased potato has become thoroughly rotten, but does not seem to have affected any of the sound ones in contact with it; from which I infer that the disease is simply *epidemic*, not contagious or infectious.

My experience would lead me to suggest the cup variety as the safest plant; to allow the tubers to be quite ripe before taking up; to pit them in rather narrow pits, in dry weather, on dry ground; and to leave them undisturbed until they are going to be made use of.

I may observe that two years ago I dug part of my cups early in October, and a great part of them rotted in the pits; while the rest of the crop, which was not dug until November, kept quite sound.

No. 8.—Mr W. F. CAMPBELL of Islay. March 16, 1846.

1st, The disease was first observed in this island in a field facing the south, near the village of Port-Ellen, in the first week of August. This appearance was first observed by the withering of the leaves and stems; about the 20th of August the tubers were found diseased; and in this field, and some others in the same locality, with the same exposure, the decay was very rapid; in other parts of the island, little, if any, disease was observed till the potatoes were lifted.

2d, The cups have very generally escaped the taint. Fields with a northern exposure are much less affected than any other,—the southern and eastern exposures are the most affected. The point of the Rhinns of Islay, surrounded by the sea, was quite free from taint. Potatoes planted in moss and in sand are much less tainted than in strong and deep soils. At Ballinabeg, where the potatoes were planted in sandy soil, and with a northern exposure, there is not one tainted potato. The crop there, and over the whole island, was very far above an average. Potatoes raised from seed are in general worse affected than those raised from sets of potatoes grown in the island for 100 years. Potatoes planted early, so as to be ripe, or nearly so, in the last week in July, are perfectly free from taint over the whole island. On my own farm I had one-half of a field which was very early planted, with the same seed and manure, in the same soil, and with the same exposure, with the other half which was planted late for seed. The half that was planted early was ripe, or nearly so, in the last week of July—there

was not the slightest taint in any one potato in this half of the field; on the other half the crop was very great, and was in its greatest vigour in the last week in July,—every single potato was more or less affected, and the whole of them have been converted into starch. From the part that was early planted I have still 15 tons of potatoes perfectly free from the slightest taint.

American early, London blues, Forty folds, &c.—early varieties, grown in the garden, for the use of the house, are quite free from all taint.

You state in your letter, that you do not wish for any lengthened statement. I deem, however, that I best consult the object of your inquiry by making a short remark, viz.:—That from the above statement I am confirmed in the opinion I formed at a very early stage of this disease, viz., that the fungi and animalculæ observed in the diseased potato are the consequence and not the cause of the disease. I attribute this scourge to a very simple cause,—one that often takes place in America, where the disease has been long known,—namely, the great variation of temperature between the night and the day. In no year have I ever observed so great a fluctuation as took place both in July and August; for instance, on the 17th of August the difference was from 36° at night to 72° in the day—the well-known consequence of such great and sudden fluctuation is sure, by the rapid expansion and contraction of the juices of the plant, to cause the rupture of the cellular tissue, and this, I have no doubt, was the consequence with the potatoes this year. The latter end of August was very wet, from which cause this rupture of the tissue was prevented from drying up, and the wound became a slough and gangrene, which spread through the remainder of the root, and, like other putrid vegetable matter, produced and fostered both fungi and animalculæ.

The tissue of the potato that was advanced to maturity was firmer, and not so liable to rupture.

The cells were, in the ripe potato, charged with starch, whereas, in the unripe, they were charged with sap; and, therefore, in the latter case, the potato was far more sensitive to the expansive and contractive power of heat and cold.

Potatoes, therefore, that were ripe at the end of July, did not suffer by the violent alternations which began at that period, and are free from taint.

In southern and eastern exposures, the sun had earlier and greater power; the alternation was, therefore, greater and more sudden than in western or northern exposures. The disease, therefore, if this explanation is just, would be greater in a southern than in a northern exposure, and so it was. The same explanation can be given in every case. Moss is a bad conductor; there the potatoes did not suffer so much. In sand, potatoes are never so succulent, and arrive earlier at maturity; in it, therefore, they suffered little. In positions exposed on all sides to the sea-air, the temperature is almost always equal; in those positions there was no taint at all.

3d, The potatoes were stored in the common way at first—in pits a yard wide. When the disease was observed the pits were opened, ventilated, mixed with well-slaked lime and sand, and very lightly covered. The pits were frequently looked at; the tainted potatoes were known by the lime adhering to them, which it did not to the sound ones. The diseased tubers were converted into starch, or given to cattle and pigs, and the pits covered up again. This was frequently done, and by this means very few potatoes were lost. They were also kiln-dried; but though this arrested the disease for a short time, it returned with greater violence after a short period, and all that were kiln-dried became a total loss.

Lime and dry sand, and exposure to a stream of cold air, in many instances dried up the disease of partially decayed potatoes, leaving a white lump where the brown slough had been, and these are now quite sound.

I humbly suggest, that if any seed is planted with the disease in an active state, the gangrene existing in activity will give the disease, or rather the gangrene will spread along the fibres to the young tubers; but if the gangrene be cut out, and the wound cauterised with hot lime, I will venture to predict, that without a return of the same violent fluctuations of heat and cold, that there will be no return of the disease this year.

No. 9.—Mr John Clerk. Balamore, 21st March, 1846.

We saw no appearance of disease till the potatoes were stored. I stored them in the usual manner; the only precaution I took was to put as thin a covering of earth on them as I could. They were quite sound when I covered them, but in the course of three weeks I noticed one of the pits diseased. I began picking the tainted potatoes, but found that this was no preventative—those left as sound were, in the course of ten days, as tainted as those taken away—so I left them as they were, until about a month since, when I saw there was a prospect of getting them sold, and then began to pick them. I found some parts of the pits almost all gone, while other parts of the same pits were almost sound. Most of my potatoes were grown where never potatoes were grown before, but I found them as bad as those raised on old or often used land. I should state that I had air-holes on each side of the pits, six feet apart; but cannot say that this had a beneficial effect. We are fairly at sea, both with regard to the cause or the cure of this fearful disease; the only thing we are all agreed upon is, that those manured with sea-ware have been decidedly much more affected with the disease than those grown with common dung. I had a note from Mr M'Dougall, in November, asking me to keep some bolls of cups for him. I sent word that they were all diseased; indeed, it was in them I observed the disease first; and they were grown in the bog between my house and the school-house, which I have drained since I came here, and certainly where potatoes were never grown before. We have not much reason to grumble this year, though we have generally lost about the one-fifth; still we have received so very good a price for what we sold, that we are tolerably well off. The only man in the island who lost all his crop is M'Lachlan Ardmore. I am told he has not a potato either to sell or plant.

But what are we to do for the next season? Is it advisable to plant the usual quantity, and take our chance of the disease, or should we try turnips? I am loath to disarrange my rotation system by sowing barley or oats; but I am quite at a loss what to do.

No. 10.—Mr Allan M'Dougall. Dunolly, 24th March 1846.

As far as I can learn, no disease worth alluding to, and no partial failure, has, at any period during the last thirty or forty years, affected the potato crop in the district of Lorn in this county, and in no part of Scotland has potato culture proportionally (i.e. to the extent of land in cultivation) extended itself more, and become a staple, than it recently has in this district, and I believe I may add Argyleshire generally. Towards the middle of September last, having noticed in some agricultural periodical that the potato crop in some parts of the Continent had been observed to be affected by disease, and that it indicated itself by a black spot upon the leaf, from which it was said to descend by the stem to the tuber, I was led to examine the potato field here. I found, upon examining the leaves, that a very few were so marked, but could find no apparent symptom of disease in the stem of the plant containing the leaves so affected, nor any unsoundness or discoloration in any of the tubers of the same plant; and, confidently believing that I had before frequently observed a similar black spot upon the leaf, without any harm ensuing, and believing the black spot to be the result of frost, and knowing that we had, before the examination, one or two nights of white frost, I thought no more of the matter. It was last autumn remarked to me by persons who reside throughout the year in this part of the west coast, that they had a remarkably dry summer, and with less heat than might have been calculated upon for so dry a season. The only remark that occurred to me on the appearance of our field of potatoes, in the course of September last, was, that the stem and leaves appeared to have decayed sooner than usual; and the inference I drew from this was, that the crop had ripened this season sooner than usual. The corn harvest in this district was last season a late one. Early in September it came to rain almost constantly. The potatoes were apparently generally ripe before the end

of September; but owing to the late corn harvest and wet weather, very few farmers began to raise their potatoes before the 12th or 15th October. From this date the weather had been for a length of time wet, stormy, and most unsettled. It was between the 16th and 24th October that the potatoes on the home farm here were raised—the ground had been for weeks saturated by rain—the weather was at the time alternate breezes of wind and showers, and the wet roots were stored in pits in the wet field. The potatoes were of the red and blue kinds, very fine looking tubers, (at least the red were so,) and the crop about a fourth greater than that of 1844. Although apparently a beautiful crop, I was very much afraid it would not keep, in consequence of the wet state of the tubers, soil, and weather, (the soil was not, however, naturally wet, and was partially drained.) About the time our potatoes were stored, the newspapers began to teem with accounts of potato disease. Eight days after the pits here were closed, I had them opened; and, upon examining the potatoes, I found many of them had a small white downy or woolly-like excrescence, about the size of a No. 4 lead shot. Upon cutting potatoes bearing this external mark, I found them all more or less of a brown colour, shaded from a very dark to a light hue, which apparently was rapidly spreading, and evidently the forerunner of rapid decay. I had instantly the infected removed from the sound, and procured a quantity of lime and dry sand. I had the pits much reduced in size, and restored the potatoes that were free from disease to the pits, one portion of them being well sprinkled with lime, and the others packed in a liberal allowance of sand. A small portion I had taken to the offices, and packed in dry ferns. The new pits were well ventilated by holes in the ridges and along the sides. Ten days after this treatment I had the pits again examined, there was no appearance of disease whatever in the reds, but some were unsound in the blues, whether stored in sand or lime. As the blues had shown from the first the greatest tendency to the disease, and being also fortunately the least in quantity, as well as of inferior quality to the red, I desired them to be first used. They were accordingly freely given to pigs and poultry from the beginning of November till the first week in February, by which time they were all used up. The disease continued amongst them in a small degree to the last. I calculate we here lost about a 12th part of the whole crop of potatoes by disease; but as the crop was nearly a fourth greater than the preceding year, we had thus a greater quantity of sound potatoes than in 1844. Potatoes have, however, been this year so freely given to pigs and poultry, that the stock on hand to-day is less than on former years at the same period, perhaps it is three weeks or a month's consumption less. What remains of the potato crop is still in pits, one half in lime, the other in sand, and are perfectly sound and of first-rate quality. The potatoes that were taken from the pits after the disease was discovered, and stored in the potato-house in dry ferns, and so kept, have not done so well as those left in the field in sand and lime; one half of them were destroyed by the disease, though kept perfectly dry.

I may add, that from the information I have from time to time received, I am inclined to say that, in the district of Lorn, the crop of 1845 was a seventh greater than that of 1844, and that two-sevenths of the last crop were lost from disease. Most tenants will, however, have to admit that, in consequence of the price they have been getting for the remainder, they have no reason to "*grumble.*" The real sufferers are the poor cottars, who have lost much of their small stock, and had never enough to be able to sell any.

No. 11.—Mr Dougald M'Dougall of Gallanach. 21st March 1846.

1st. There was no perceptible difference in the appearance of the stems previous to digging the potatoes from that of any other season.

2d. The only two kinds of potatoes in general use in the district of Lorn, are what we call the rough reds and pink eyes. They did not begin to rot till they were some time in the pits, when few or none escaped. With the exception of those who planted some in moss with sea-ware, there has been generally a

loss of from a half to a third of those that were put in pits, while those that were put into the house escaped better; but no one seems able to give any good cause for the disease.

We are an exporting district, and from the inquiries I have made, about 9000 tons are annually shipped to Liverpool, Glasgow, and occasionally to Ireland, from the following parishes:—

Kilmore and Kilbride, ...	2000 tons
Kilninver and Kilmaford, . . .	1000
Kilbrandon and Kilchatten, . . .	2000
Lismore and Appin, ...	3000
Ardchattan and Muckearn, . . .	1000
	9000

The steamers are at present loaded with potatoes for Glasgow, and numerous cargoes are sent by vessels, and those which have escaped the disease are of excellent quality.

3d. Every mode that could be devised was tried to prevent the extension of the taint, but with equally little success, as many were of opinion that it did more harm than good opening the pits during the constant wet weather. In winter, my potatoes and those of the clergyman of the Parish were the only ones that escaped the present disease: the only cause I can assign for which was, that the minister's were planted in moss and gravelly soil, and mine were covered with chick-weed.

No 12.—Mr Alex. Gordon, Garvie Glendaruel, by Cairndow, 1st May 1846.

1st. It was about the latter end of September we first observed any unusual appearance in the stems of the potatoes; and about that time, and towards the first week of October, they began to show symptoms of premature decay, similar to that presented after a severe night's frost, (or rather from the effects of a severe night's frost,) with this difference, that when destroyed by frost, a few inches of the stem nearest the surface of the ground still retains its sap, which in this case it did not, for the whole appeared to be alike blanched.

In most cases the potatoes came beautifully into flower, and the general impression was, that the crop would be heavy. The disease had not manifested itself at the time the flowers naturally give place to the apple or seed; but as far as my own observation went, and several to whom I spoke on the subject seem to have the same impression, the crop of last season was very deficient in apple.

The taint, when first attacking the potatoes, could only be discovered by cutting the skin, when they presented a brownish colour, with the same appearance as when attacked by ulceration. The part affected when boiled, generally came out from the potato in a hard lump, and the remainder of the potato was as well flavoured as ever; and this was generally the case until the larger half was affected.

The weather for the most part of the summer was wet, but not cold, generally very little sun; but about the 24th of September the weather became very cold and wet in this district, and continued so for at least nine weeks.

2d. We formerly cultivated few or none but reds, as they commanded the readiest market in Glasgow and Greenock, where they were invariably sent. A few dons were cultivated by the cottagers, but more for their cow and pig than for family use. Near the shore-side a few Irish cups were planted, but the lateness of that variety has prevented its general adoption in the district. Early planting is attended with risk, as we have often frost about the middle and towards the end of May, which cuts off the stems when two or three inches above the ground, and late varieties are liable to be damaged by frost as early as the middle of October. I am unable, therefore, to speak of any other variety; but those above named, and of these the cups have suffered least. The reds may be said to be nearly lost in this parish, (Kilmadon,) as there is not one-eight part

remaining of what was in former seasons at this time. The means used to produce a heavy crop has tended much to this, as, whenever the land was in the highest state of cultivation, and the crop heaviest, there was scarcely a possibility of preserving them: the same remarks apply equally to all sorts of soil in a high state of cultivation.

There are two farms in this parish, and adjoining each other, and both rather poorly cultivated: on one the whole crop has entirely failed, on the other it is perfectly sound. The sound crop looked very poorly in summer, and not like to pay the tenant much; but I saw the pits opened a few days ago, and no trace of disease whatever; and what is more strange, one of the pits was dug from a hollow in the field, which is generally damp, and was considered at the time of pitting as not likely to keep.

Another strange thing in connexion with this is, that the seed has not been changed for some years, and was always considered to be a little tinged with dry-rot. Until seven years ago, this farm was in the hands of a person who reduced it until past bearing crop of any kind, and the present tenant has never had green crop in this field until last season.

No potatoes have been raised from seed in this quarter that I am aware of.

3d. The principal means employed to preserve the potatoes after being dug has been to put them into small pits, and mixed with earth. Some people have mixed them with quick-lime, and ventilated with drain tiles; but neither of the modes have been successful: those pitted without either lime or earth, if at all diseased, decayed very fast if turned over and exposed to the air. Those who had land dry enough to leave the crop in the ground all winter, or who lifted them and drilled them in again in dry land, (the produce of two or three drills in one,) have been able to preserve a considerable part of their crops; and I believe I am safe in saying that this has been the most successful mode of preserving potatoes in this quarter.

Whatever may have been the cause of the disease, in this neighbourhood at least we intend to apply less manure to the potato crop—say, one-half the usual quantity, and the other half to the land before ploughing it for white crop. We may be wrong in supposing that over manuring has been one cause of the disease, since all the farms that have escaped are not to be supposed to have been different in that point, but in my experience I have always found that potatoes planted in the last week of March or first week of April, take more manure to produce the same weight of crop than those planted in May. I attribute this to the land being colder at the earlier period; and hence the reason the more elevated lands have so much escaped the disease.

In this district the potato crop is manured at an average rate of forty tons of farm-yard manure per acre, which produces heavy crops on the lower grounds; difference of altitude making a difference in the crop of from a third to a half. It may be that the land is incapable of producing such heavy crops, and it remains to be proved by experiment, whether the application of an additional quantity of manure would produce a corresponding addition of crop.

No. 13.—Mr Lachlan M'Lean. Tobermory, 15th April 1846.

About twelve years ago, when residing in a neighbouring island, we had a rainy season with little summer heat; so my potatoes were late of ripening, and were lifted about the usual time, with the shaws or tops gone, or mostly so. Some were secured in pits, and some in a house in the ordinary way. Early in spring some appeared diseased, and in May the whole of a large crop was gone. I had known and heard of the disease in the neighbourhood previously. Many of the sets for the next crop failed. In the diseased potato, there was a hard lump near the part attached to the stem, from which the disease pervaded the whole; and on being cut across, it exhibited the same brownish appearance as of a spoiling apple, with numberless specks, and some of them very minute. Having observed in the succeeding crop a few tops with the appearance of

health when the slips planted had entirely rotted in the ground, it occurred to me that I was guilty of two mistakes, which occasioned the loss of my potatoes, viz., late planting and premature lifting. I was led by this to consider, that the first shoot from the potato is the most vigorous; that the potato from which the first shoots are taken is injured, and produces a more delicate or sickly shoot; that consequently the potato does not ripen so early—notwithstanding a contrary theory. that the potato is not sufficiently matured for lifting while the tops are green and sappy, by which, in some seasons, the crop may be injured by premature lifting—and that potatoes ought to be planted when they begin to sprout, or rather earlier. Next season I guarded against early lifting, but planted at the same time. A few became diseased in spring, but none survived the month of May. The next season I prepared, by draining, &c., a piece of ground, partly moss and partly shingle, over retentive clay, in nearly equal proportions, one end of the field being moss right across, and formerly cropped in narrow stripes, owing to the extreme wetness of the ground, for it was never drained. I planted my potatoes in January, February, and March—gave the ordinary quantity of manure—a compost of moss, sea-weed, and dung. Covered the sets with about three inches of earth. Small potatoes were planted whole; large ones cut into large pieces or sets. It was all spade-work. The season was more than ordinarily frosty and severe. The whole sprouted early, appeared strong and vigorous, and though checked by a few frosty nights in May, the whole continued throughout the season to show extraordinary vigour. The crop ripened at least a fortnight earlier than those planted at the usual time, and the produce was very abundant and sound, being as nearly as I could ascertain twenty-five returns for seed. I observed there was no advantage in planting so early, for all sprouted at the same time, as might be expected. The early planting arose from imagining that the sets would be better preserved in the ground than in a house or pits. It is uncertain if this is the case. On examining different parts of the field, when the tops were appearing, some of the sets had quite perished; nevertheless the result was what I have stated above. For the few years afterwards that I farmed, I planted early, when the potatoes were beginning to sprout, and had no diseased ones. I have thought it proper to send you these simple facts without a comment.

No. 14.—Mr Colin Campbell. Craignish Castle, 11th April 1846.

The only potatoes that entirely escaped the disease in Jura were grown in dry moss near the sea-shore, and were dug early in September. I may also add, that all my early potatoes have escaped the disease.

No. 15.—Mr William Rutherford, Overseer, Craignish Castle, 10th April 1846.

1st, In the first week of September, on entering the garden one morning, my attention was arrested by the appearance of the pease; they seemed as if covered with hoar frost, and as I proceeded to examine them, my clothes, on coming in contact with them, became tinged with the mildew, and appeared of a light green colour. I also observed that the kidney beans, cabbages, and vegetables in general were similarly affected. I then passed from the garden to the potato fields, and was at once struck with the altered appearance of the tops, or shaws of the potatoes The stems, which on the preceding days were green and healthy, were now shriveled as if nearly ripe, and covered with a fungus. My decided opinion is, that this fungus passed from the stems to the tubers, and produced the disease. On examining the tubers after the taint had extended, I discovered it as of black colour through the outer rind of the potatoes; and when the potatoes were boiled, they had a sweet taste, as if touched with frost. The wind north-west, and the weather for the preceding six months exceedingly dry.

2d, I found the different kinds of potatoes equally affected; nor do I consider that manure had any tendency to produce or prevent the disease. On this point I am able to speak with certainty, as potatoes were planted on the farm with different manures, and on various soils, but were alike tainted. I however observed, that when they were sheltered by a stone-wall or trees, or when overgrown with weeds, that they were not diseased, and have continued sound. Also that small ones, which had been picked out of the smooth red sort in the last week of August, have kept well.

3d, I was accustomed to store the potatoes in pits covered with turf and earth, and also in houses which, in general, I filled up to the height of 6 or 8 feet, this year, however, to the height of 18 inches, to allow room for turning them, which I did once a month. I do not consider the disease infectious, as I had potatoes raised under the shelter of a wall, and although stored in the end of a diseased pit, they remained unaffected. I may observe, that I preserved them in the house by mixing them with dry peat-dust, and turning them monthly. I regard this to be the best mode of keeping tainted potatoes, as it prevents them from heating which gives a stimulus to the disease. I may also add, that I consider that good seed may be obtained from potatoes partially tainted, and for this I would recommend that the tubers, when cut, should lie spread upon a floor for 24 hours, as from experience I have found that the incision in the sound potatoes dries up, while in the other it continues moist and assumes a red colour. I am of opinion that, in this way, the diseased could be separated from the unaffected and proper seed obtained.

No. 16.—Mr William Kennedy, Factor, Strontian, 30th March 1846.

During the past season there was nothing peculiar observed upon the leaves or stems of the potato. On the contrary, the appearance of the crop was luxuriant, the stems vigorous, and at raising time both the quantity and quality realised the expectations of every one. No disease manifested itself until about the 24th of the month of October, and even then it was but partial and confined to certain localities. In the district of Sunart, composed chiefly of a dry granite soil, the potatoes appeared very fine when raised, but the disease attacked them, and made very considerable progress; while, in the adjoining extensive district of Ardnamurchan, lying chiefly upon trap and limestone rock, they have kept even until now entirely free of disease.

The tubers affected, when cut up, resemble a bruised apple, the disease apparently extending from eye to eye, and at first only affecting the surface, to the depth of a quarter of an inch. I observed also a few tubers, the one half of which was destroyed by parasitical fungi, while the other remained sound. When these were exposed to the atmosphere, in a dry place, the disease made no further progress.

On the west coast of Argyleshire, the summer months and the autumn of 1845 were very wet, little sunshine, and an unusually low temperature. The period for housing the potatoes was also very wet.

In reply to the queries in No. 2, I have invariably found within the district, that the potatoes called Connaught cups have escaped the disease. A few days ago, I had an opportunity of very carefully examining a pit composed of various kinds of potatoes. A portion of them were cups, and while a considerable quantity of the other kinds were entirely destroyed by the disease, the cups remained quite sound.

The Perthshire reds have been generally less affected than the pink-eyed description of potatoes, which latter presented a fine appearance when raised; but the disease attacked them very generally, and with all the exertions used to save them, by re-pitting and selection, a very considerable portion in the granite district have been lost.

From the experiment made by Mr Thomas Smith, overseer to Sir James Miles Riddell, Bart., of raising potatoes from seed, and which was reported to the Highland and Agricultural Society, the fact has been distinctly ascertained, that

potatoes obtained from seed have been more liable to this fatal disease than those raised from sets and tubers, in the usual way.

With regard to the particular condition of soils, potatoes grown in very wet land have this season been lost in larger quantities by the common rot, while those raised upon dry hard soil have been more liable to the attacks of the new disease. It is of much importance also to notice, that potatoes grown in moss land have been generally free of the malady, and in any instance where the disease appeared in potatoes thus raised, it was more successfully checked by adopting the precaution of spreading out the tubers, partly picking them, then re-pitting in small narrow pits. It has been found also that potatoes have kept better, when mixed with a little dry moss or earth. I consider this a good precaution, under any circumstances. I have likewise observed, that more disease exists in potatoes raised in land previously under high cultivation, and richly dressed with common manure.

With regard to the influence of different kinds of manures, I beg to state, that I planted about half an acre of land, lightly manured with Ichaboe guano. The crop ripened early, and the potatoes were pitted in the usual manner. The rest of the field was richly dressed with common manure, and planted with the same description of red potatoes. In the month of October, the disease attacked the potatoes raised on the common manure, and I lost fully the one half of them, while those raised from the guano have continued perfectly sound. I have heard of another experiment of the same kind, with a similar result.

In general, potatoes raised from fresh sea-ware have resisted the disease better than those planted on common manure; and I am consequently of opinion, that the method of raising seed from fresh sea-ware, on new moss, might be found to be beneficial. This system would accomplish two very desirable objects, viz., to produce potatoes less liable to disease, and to reclaim waste land.

In reference to the modes employed in storing the potatoes, the usual practice in this district is to form the pits from 3 to 3½ feet in width, and to cover the potatoes with divot or turf, or dry ferns, and from 8 to 10 inches of earth. A great error is frequently committed, by placing too great a body of potatoes together. I have observed numerous instances of much loss arising from this cause, and the disease so prevalent this season exhibiting itself at a much earlier period in large pits, while none of it appeared in the smaller ones of the same description of potatoes, made at the same time, in the same field.

Numerous methods of storing the potatoes were adopted when the disease was discovered—such as ventilating the pits, packing the tubers in dry sand mixed with lime, so that no two potatoes touched each other, using a mixture of charred wood and dry earth, and an alternate layer of sand—but all these attempts to save the potatoes proved entirely unavailing, and in some instances hastened on the disease. My experience and observations satisfy me that the most practical mode of preserving the healthy tubers is by putting them in narrow pits, mixing the potatoes with a little dry earth or moss, and using as a covering dry divots or turf, and then adding about ten inches of earth.

When the disease has once attacked the potato, it is a difficult matter to prevent the extension of the taint. The only plan found useful was the frequent and timely separation of the sound potatoes from the diseased ones.

Sir James Miles Riddell tried the experiment of leaving every alternate drill in the ground when the crop was raised, and earthing them up so as to prevent injury by frost. The experiment was tried in moss land and also in granite soil.

The result has been somewhat singular. The potatoes grown in the granite soil, earthed up in this manner, have continued quite sound. Those in the moss land, near the surface of the drill, are partially diseased, while the potatoes deep in the moss are sound.

In concluding the above remarks, I would beg to urge upon all who raise potatoes, the propriety of not manuring the next crop so richly as formerly; and, where it is practicable, to plant that valuable article of food upon new land, which has never been under potatoes previously.

No. 17.—Mr Mungo N. Campbell. Ballimore House, 5th May 1846.

In answer to the queries on the subject of the potato disease, I have to state that the attention of parties in this locality was not generally drawn to the subject at an early period, in fact not before, or perhaps in most cases not sooner, than the period of lifting the crop; and even then, it was more occupied in devising schemes likely to preserve the sound potatoes from becoming totally useless, than the nature of the disease itself. These schemes were, in general, pitting in much *smaller* quantities than was usual, taking care to exclude as far as possible any infected potatoes; and ventilating the pits, as well as washing with lime, and spreading the potatoes on a dry floor—this latter I practised myself with a portion of the crop, and though a few potatoes were obliged to be thrown aside, yet, on the whole, the quantity so treated appeared to be good seed. Among the most successful instances of pitting I heard, was one in which the potatoes were placed in alternate layers of dry sand, from which they were not removed till planting time, when the seed appeared to be very satisfactory.

It seems generally admitted that the variety of potato called Irish cups was less affected with the disease than either of the reds, which are the varieties almost entirely cultivated here—but those who had cups found them to stand best.

No. 18.—Mr James M'Innes, gardener to Mr Malcolm of Poltalloch, Kilmartin House, by Lochgilphead, 14th May 1846.

1st, About the beginning of September the disease began to appear in this district, exhibiting dried, white, burned looking spots on the stems, the leaves appearing of a brown scorched colour, and the greater part of the flowers dropping off. Fields which were quite fresh and green became to all appearance dead in the course of 7 or 8 days after the disease first showed itself; the stem being dried up, and the taint extending itself to the tubers in the form of soft brown-looking spots full of water. During the month of August we had 2.8 inches of rain, and the temperature ranged from 63 to 76 degrees Farenheit in the day, and from 41 to 56 degrees in the night. The lowest was during the night of the 21st of the month, the wind being westerly.

2d, It does not appear to me that any of the varieties of the potato have been less subject to the disease than others, and even those obtained from seed were as subject to the taint as those long raised from sets or tubers. The crop, where grown in moss, has been less subject to the disease than in any other kinds of soil.

3d, The modes of storing the potatoes here have been various, such as ventilating the pits, mixing the tubers with lime, sand, or sawdust, and pitting without ventilation; the latter modes proved the best, except those stored with sand and *ventilated*, which were most decidedly the best preserved of the stored lots; but those left in the drills as they grew, and even where the taint was very decided, proved in the spring to be the best. The mode adopted for this trial was removing the decayed tops, taking up the alternate drills, and covering those left in the ground with the soil from the drills where the potatoes were lifted,—more than half of the potatoes of the raised drills were lost, while those left in the ground had scarcely a failure. Three kinds were tried in this way, viz.,—blues, pink eyes, and Irish cups, and the results were nearly similar.

General Remarks.—I am of opinion that the disease was caused by atmospheric influence, for it exhibited itself where the plant was exposed to the west; but in situations sheltered by plantations or high hills, from the north and east, it almost entirely escaped. I am strengthened in this opinion from other plants being affected in a similar manner at the same time, in aspects such as I have described. The effects on the common fern (*Pteris aquilina*) were very striking.

I am not of opinion that the disease has been caused by any particular *degree* of temperature, but by some electrical or peculiar state of the atmosphere.

In the south of Europe where they get two crops—(See *Gardener's Chronicle*

of the 18th April 1846)—it appears that the potatoes raised in June 1845 were perfectly good, while those lifted in October following were diseased, the latter having grown during the highest temperature.

No. 19.—Mr Richard Campbell. Auchinbreck, 15th May 1846.

From my own experience I can only say that what has been successful in one case has not been so in another; potatoes left in the drill all winter *have* kept pretty well, and *have not* kept better than those in the pit; one case of drill answered very much better than others; it was a dry gravelly knoll, but here too there was a failure. Some grown upon the same field were to the north, and better than the south, which was to be accounted for by the south end being more of a peaty nature and *open*, the north not so open. Small potatoes for setting, which were selected and put up by themselves, were fully worse than the larger potatoes.

I found that potatoes grown on sandy gravelly soil, near the sea, did not keep better than those grown upon good light soil within reach of the sea breeze.

No. 20.—Mr Samuel Mitchell. Strath, Campbeltown, 5th May 1846.

1st, The weather, from 12th to 16th of July last, was exceedingly close: the air compressed, dry, and fiery. On the 17th, this district was visited by uncommon heavy rain; immediately afterwards the rank-shawed potatoes on my farm, and that of my neighbour, became quite black. I am of opinion that the leaves and flowers were first affected by the fiery air, then the stem; and from the soft state of the root at the time. this infection went from the stem into the potato. Had this fiery atmosphere been a few weeks later in the season, when the stems and root would, to a certain degree, have been separating from each other, it would not have done so much damage. I have, in previous years, seen blight affect potato fields; yet, on account of their forward and nearly ripe state, the disease did not enter into the roots, the avenue connecting the stem being almost, if not entirely closed up. Four years ago, in the month of August, the atmosphere at the time being surcharged with fiery matter, a nauseous smell was emitted from a field of rank beans on my farm, and in a day or two after they became quite black. On the same occasion, the potatoes were observed to have a strange disagreeable taste, and were for a time unpalatable.

I am of opinion that if this had happened earlier in the season, we would in that year have had the same lamentable deficiency which we have now to deplore.

2d, And as a proof to my first answer, the potatoes earliest planted, and nearest their ripe state, escaped the disease, with the exception of the green shaws in the field; and as the red is a much earlier potato than the white, it escaped better, being in a more forward state; and the cups escaped better than the white, owing to being a firm potato, and equal to the red in gravity, and possessing less fibre or spongy substances. Any potatoes on high lands did not suffer so much as those on low soils; and the sea-air had the effect, along the shores, of preventing those on sandy soils from being so badly affected. I had the end of a field of mossy land that was not rank, but in a forward state; they escaped the disease altogether, but the other end of the field was very bad.

3d, The best mode of storing them is to pit them in narrow pits, and cover them with a little straw, and turn them, and leave them free to get air.

AYRSHIRE.

No. 21.—Mr John Joseph Burnet. Gadgirth, Ayr, 14th March 1846.

The disease in question, developing itself in the autumn, is by no means new to this district. In autumn 1844, some farmers lost nearly half of their crop

before they could raise them; but, being confined to certain farms, it was either not sufficiently inquired into, or it was perhaps purposely concealed, to prevent those farms getting a bad name for potatoes.

With regard to the experience of the past season, which is the more immediate object of inquiry, I have to state that the disease first showed itself in my own crop in the first week of October, after a track of very wet and cold weather. During the months of August and September, portions of the crop, to the extent of about three acres, had been raised in a perfectly sound state; but, being sold off, it is impossible to say whether they would have escaped the disease had they been then pitted in the usual way.

No attention was paid to the appearance of the stems, leaves, or flowers, until the disease manifested itself in October, and the leaves and stems had been withered some time before. Black spots, like fungi, appeared upon many of the stems, and the tubers at *these* stems were invariably tainted. The disease showed itself by brown or livid spots upon the skin, scarcely discernible until the skin was broken. No varieties have entirely escaped the disease, but the cups and American early have been less affected than any other. I may also include among the partially diseased a variety called Daly's wonder, a white potato with pink eyes, and of an oblong shape, about ten years grown in this country, at first a large coarse potato, but now of excellent quality.

The disease has prevailed most upon wet heavy land, and even on drained land, if of a strong nature, more particularly where the land was naturally rich or highly manured, and in low situations. Where guano or saline manures were employed without farm-yard manure, or when unmanured, the disease has been slight, and in some cases unknown. Where the manure was ploughed into the land in the autumn, as in my own case, the disease was longer in developing itself; and, by early digging, the whole crop might possibly have escaped the disease. Early planting, however, is necessary to attain this object.

In regard to storing, every method that has been devised has failed in preserving, or in arresting the disease in those potatoes that were tainted before digging, but free ventilation and constant picking has had a great effect in *retarding*, for a time, the progress of the rot in those which were only slightly tainted. Any material that has a tendency to absorb moisture, as lime, gypsum, charcoal, &c., has been useful in checking the progress of the disease; but when once these substances have become saturated with moisture, the rot has spread rapidly, so that free ventilation can alone be depended upon for preserving tainted potatoes, until they can be turned to some useful purpose. The same rule applies to sound healthy potatoes, for the more they are exposed to the air at an equal temperature of 40 to 45 degrees, the more hardy they become, and the less liable to sprout prematurely. I have kept potatoes in a cool dry place without sprouting, for nearly two years, and they have afterwards vegetated vigorously, and produced a healthy crop. I have confined my observations to the queries sent, otherwise more might have been said on the subject of raising potatoes for seed.

No. 22.—Mr Alex. Montgomerie. Brigend, 21st March 1846.

I heard of considerable failure in the potato crop towards the end of August, when I was selling mine perfectly sound; this I ceased to do when I began harvest, and it was not till the 17th of September that I found them tainted—this was in a very dry field near the shore. I had also potatoes planted on some high ground in a field not quite so dry, and in this the disease did not make its appearance till later in the season, though ultimately these were the worst. The seed, however, was my own from last year's crop, whereas that in the low field was from moss, except Taylor's forty-fold, which I have sown for many years successfully, without renewing, and which, though last and least injured, have suffered considerably; but I again used them for seed about six weeks ago, and though some of the sets are soitish, till this frost set in there was a promise of all doing well. I saw no appearance of disease in the crop on the low field

when growing; the shaws were luxuriant, with a fair proportion of plums, (from which I have some apparently good seed,) and they did not fail before the usual time; but those in the high field did. They were planted late; and some still later on head-ridges, though the shaws were strong, had, when near ripe, some black marks on the leaf. It is not of much use to particularise kinds, as they are often called by different names in different parts of the country. Mine were principally rough and smooth reds, and a white kind called calicoes. I had small quantities of many other kinds, but all were tainted more or less, the white kinds least. Situation, soil, or manure, seemed to make little or no difference. The potatoes which have kept best are those spread upon floors, but of course this was to a very limited extent; next, those which were left in the ground, every alternate drill being lifted, and the soil laid on the ones left; these I am now taking up, and I think not in a worse state than they were three months ago. I had some in narrow pits, but these have gone to pulp; there is, however, a circumstance worthy of remark as connected with these—some few in the heart of the mass were quite sound, and they appear to be such as had grown on the top of the drills, exposed partially to the atmosphere. The disease in the potatoes this year, is one from which my crops have suffered to a trifling extent for some time past. There is one thing should be borne in mind, that the mildness of the winter must have militated very much against their keeping. I fear all the information you can collect will not throw any light on the subject, or lead to any beneficial result. As far as I have examined the different statements published, in no one point do all agree.

No. 23.—Mr John Lade. Largs, 20th March 1846.

The disease made its first appearance about the first of September, after some time of very fiery weather, and the stems, leaves, and flowers were spotted when first observed, and in a few days thereafter became brown, and soon decayed. The part of the tubers diseased was streaked in colour when cut, and harder than where no disease existed.

No variety of potatoes has escaped the disease in this quarter, so far as I know, as all have been more or less affected. Cups have been less affected than any other; those recently obtained from seed have been as subject to the disease as those raised from sets or tubers; and where soils have been highly cultivated, the disease was worse; and I do not think that wetness, or any kind of manure, had any influence whatever in promoting, retarding, or preventing the disease.

Many different modes have been employed in storing the potatoes, and various means used, such as ventilating the pits, applying lime and other substances to absorb moisture, and also by frequent opening of the stores, and separating the diseased from the sound tubers, but none of these expedients have been found successful in preserving the healthy tubers, and of preventing the extension of the taint from the diseased to the sound ones.

No. 24.—Mr D. Cunninghame. Chapelton, by Ardrossan, 18th March 1846.

I beg to state, that the farm I occupy lies upon the Firth of the Clyde, and consists of a potato-growing soil, namely, a light sandy loam. The disease made its appearance in this parish about the 25th of August, beginning in a narrow strath of land lying open to the north—entering there, and going out at the south—both ends, owing to a bend in the Clyde, being open to the sea air. The blight seemed to halt here for a time, till the 24th of September, when, after a most severe day's rain from the east, it spread rapidly in every direction. On that day I felt quite convinced of a change; for having dug some potatoes for family use the day before, which were completely sound, the day after the rain the crop was much infected, and every one in the district found the disease spreading around them.

None of the varieties grown in this district escaped; but the kind called

cups were the least affected, being only spotted on the skin, and, when kept completely dry, the disease went no deeper, and they are keeping in that state till this day, but if allowed to become damp in the pits, they eventually went wrong like the others. I am not aware of much difference regarding manures, but it was evident, that the higher the state of cultivation of the land, and the more luxuriant the crop, the greater was the disease. I beg to state regarding the cup potato, that it is a coarse kind; and by growing it these twelve or fifteen years upon light soil, it has much improved; but it is not well adapted for rich soils, as they grow too much to the shaw, and become rough and unshapely, and have red streaks through them.

The modes of keeping or storing are various, and more potatoes have been lost in this district from bad storing than actually from the disease, namely, putting them in damp into pits 4½ feet wide, with too great a quantity of them together, and covering them thick with mould. The way that was most successful, was laying them in long narrow ranges upon the surface of the ground, not allowing them to be the least sunk into it, and thatching them completely with straight drawn straw, about four inches thick, roping it well down, and putting a green turf along the top of the ridge, to assist in holding on the thatch, but not to come down upon the sides, as that would prevent the air penetrating to the potatoes, which is a great disadvantage. This is the simplest, and by far the best method that I ever saw tried, and I am quite convinced that, in this way, the unsound will remain in as good a state as when first put up; the sound will suffer nothing by lying amongst them, and there will be as few rotten as in ordinary seasons. Another advantage is, that it prevents the tubers from sprouting so early, which is the best state for those intended for seed.

No. 25.—Mr Hugh Spiers. Fairlie Ward, 20th March 1846.

1st, With regard to the failure in the sets, which has shown itself more or less, I think that it was owing to the management of the manure. The farmers have been in the habit of carting out their dung in the months of February and March, and even later, and heaping it up, which causes it to heat a second time; and when put into the drills, it is quite warm. The dung should lie in the place where it was made during winter; and every farmer should have his dunghill enclosed with a stone-wall; and if it were possible to get the landlord to erect a shed over it, it would be a great advantage. If dung is to be removed at all, it should be before New Year's-day, and then covered thick with straw on the top, as it loses a great deal of its strength when exposed to the air.

2d, With regard to the curl in the shaw, I think it was owing to the frost we had during summer, when the potatoes appeared shrivelled in the leaves, and stunted in the shaw, and did not bloom in 1844. We had no frost in the mornings here in summer, and the plants produced fine broad stems and leaves, and blossomed, and had as many apples as usual.

3d, The disease which has attacked the potato crop I regard as a calamity. We may never see the like again. The potatoes were a heavy crop, and where they were the heaviest they were the worst diseased. On the 9th of August we had a very severe frost, when the shaws were cut down at once. Had the frost not appeared till the potatoes were nearly ripe, I think the crop might have escaped. When raising the crop, the disease was scarcely discernible. I put them in small pits, hand-picked them about the New Year, and boiled the bad ones for the cattle; and I think I will have good seed. I have always sold mine for seed. My farm lies high, and I have cultivated potatoes for a long time, though not to a great extent in any year, mine being chiefly a stock-farm.

No. 26.—Mr James Wilson of Quarter. 24th March 1846.

Instead of shortly answering the queries of the Highland Society, I have considered it better to state the method adopted last year upon my lands of Quarter regarding the potato crop, by my tenant, John Craig, one of the best practica farmers in the parish of Largs, and by myself.

Upon five acres Scots, of naturally dry, light, fertile land, often planted with potatoes, he put an acre of early American, two acres of rough red, and two acres of cups—the seed was partly whole and partly cut—of the whole, the small only were taken: the American his own seed, the rough red, from higher and colder land in the parish, but some of them his own, only one year planted, the cups from high cold land in Kilbride parish. The early were planted upon the 1st of April, and all sold by the middle of September, without one tainted; the shaws (stems and foliage) continued green to the last. When the early were sold, he began to sell the late; and not one of them appeared tainted before the 1st of November. At that time, he began to raise the whole crop, and even then not more than three in a peck of 37 lbs. were tainted. More of the cups were tainted, perhaps six potatoes in a peck; they were much more prolific, nearly a third more the acre, and would produce about twelve tons—were manured with dung and guano, all the rest with manure from the dungstead alone. They were all well cleaned of weeds, the earth taken from the drills, harrowed between, and twice hoed. The new seed, both whole and cut, had no blanks, and the whole were better than the cut. The old seed had many blanks or failures, and were not so productive. He planted one drill of the new seed with the largest of the potatoes, and with the same quantity of dung as the other drills, at the distance of 20 inches in the drill—these had more than double of any drill in the field—the drills were 30 inches wide. The potatoes when raised, about 30 bolls, were put into a potato-house well-aired. The rest were pitted, some with ventilators, and some without. Those in the house began to show, about the 1st of December, symptoms of decay; they were, therefore, all sold off by the middle of December. The potato-house was again partly filled from the pits. When taken from the pits they were as little diseased as those housed, and the ventilated no better than the unventilated; and they continued so until the whole were sold, about the end of January; at which time there was not above a peck in the boll tainted. Upon the cups the blossom was general; upon the rough red scarcely any, and no plums. Nor did any of the stems in the whole field exhibit any excrescence or *baby tuber*. According to the time of planting, the *shaws* decayed—not all at once, but continued to decay from the middle to the end of September. They, however, withered earlier than usual. I do not attribute that to the wetness of the season, nor to the state of the atmosphere, but to the gradual decay of the plant, which has for the last ten years appeared in various parts of the country by partial or total failure. This must arise from the plant turning less vigorous, by too long planting in the same soil and climate. This year the taint is very different from that occasioned by wet: in that case, the potato becomes at once a soft, fetid, putrid mass, and is, from the very commencement, unfit for food for hogs. The present disease I have seldom or ever seen take place sooner than the month of May, when potatoes generally begin to decay. It is a kind of dry-rot, showing at first a very small yellowish-brown spot, gradually extending, but slowly, and sending to the surface a substance like mouldiness, not unlike hoar-frost, and the tuber may be eaten with safety, until absolute putrefaction takes place. The disease of the potatoes of this country being general, it may be styled an epidemic, showing that it has arrived at an imperfect crisis—a crisis not final—beyond which a sure crop never can be counted upon, but which may be mitigated by change of seed, change of soil, and change of manure, but never can be cured. The only sure remedy is to obtain, from the native plants of America, new seed.

The seed raised in this country from the plum will partake of the nature of the parent, and decay; so also will the plant, whether greened by exposure to the sun or not The disease cannot be attributed to frost, for here we had no frost, and the most tender greenhouse plants exposed to the open air did not show even a single shrivelled leaf. My tenant also planted upon higher land, thoroughly drained, consisting of a deep loamy soil, a little part of it tending to moss, and upon which potatoes had never been planted—two crops of oats were taken off to reduce the clod—the field consisted of two acres—the seed planted principally cups—a few rough red, and a few American early—all of the same

kind as the new seed of the five-acre field—the seed was partly cut and partly not—the manure guano alone—the field was free of weeds, so that the earth was not taken from them—but they were twice hoed, in order to prevent greening by exposure to the sun, which renders the potato unwholesome, unpalatable, unsaleable, unprofitable, and unfit for hogs, producing only a small batch of small trash round the stem. This field was raised upon the 20th of October, and pitted—very little of the pit ventilated. It was covered with six inches of soil, and thatched;—it is now the 24th day of March, and upwards of 15 bolls of the cups were housed—in a boll there is not six tainted potatoes. About fourteen days ago, he planted about an acre of the American, to save the buds, and also a quantity of the rough red—of these very few were tainted.

Upon the 10th of May, I planted with the spade—upon ground rather cold and heavy, but which had been in pasture for twenty years, and was in lea, upon which potatoes had been but once planted, about an acre, with manure from the dungstead; the seed was the rough red, same as my tenant's new seed, and the pink-eyed calico of my own seed, obtained the year before from high ground. I cleaned, and twice hoed them, having previously digged them between the rows; the shaws continued green ten days later than any of my tenant's—till about the middle of October. I began to dig them about the 1st of November; the crop was excellent in quality, and abundant; I pitted them on the field, and picked the tainted out, viz. about a peck in the boll of the calico, and about the half of that in the rough red. They remained in the pits till the middle of January; and at that time, when I housed them in a well-aired place, there might be a peck of the rough red tainted, and about the double of the calico. They have been since overhauled and picked, but the taint is still increasing.

At the time my tenant was planting, from the 20th to the end of April, the weather was uncommonly dry and warm, and oppressively hot to the out-door labourer. My tenant's two acres planted in the new land, and manured with guano, were eight days sprung before any of his other potatoes appeared above the ground. Some of my neighbours, expecting to save their seed better, left a part of their crop undug. These they have been trying, and find their loss greater than if they had been dug in the proper season. One of them has ploughed his down, and another finds he has suffered a good deal by allowing them to remain. Of the rest I have had no information, but am certain they will likewise repent such folly.

No. 27.—Mr James Paterson. Carsehill, Kilmarnock, 25th March 1846.

1st, The disease made its appearance in my potato fields about the second week of August, the shaw of the potato assuming a yellowish faded appearance, as if becoming prematurely ripe, and showing spots on the leaves; and when the crop was examined, a few of the tubers were decayed—the weather previously being mostly wet and cold.

2d, I had five different kinds of potatoes—known here by the names of rough reds, smooth reds, cups, dons, and a black potato—the seed from high moorish land newly brought into cultivation. I had three kinds of manure—farm-yard manure, town ashes and privy, also guano with a half-quantity of dung. I could perceive little, if any difference, from the manures; and as to the different kinds of seed, they were all so much diseased, perhaps about one-third of the crop when raised was left upon the ground, unfit for any use, with the exception of the cups, not above one-sixth of which were unfit for use at that time. I had none planted that were newly raised from seed that I was aware of; but learn from those that had them that they became diseased also.

3d, I am convinced the best method of preserving is to raise them in a dry time; to put them into long thin pits, upon the surface of the ground, in an airy situation, where the wind may blow through their covering of straw. Lime mixed amongst them assists in keeping them dry, but does not appear to arrest the disease. I find the less earth put upon them the better, provided frost can be kept out.

I may mention that five years ago I received from a friend in the city of Mexico a small quantity of potatoes. I planted a small portion of them each year ever since. It was June when they arrived; the first year they were very small, but are now nearly an ordinary-sized potato; they resemble much the cup potato, both in shape and colour; the shaw grows to a great length, with very few branches; the potato very soft, but is yearly becoming better in quality. I gave a few to a neighbour when I received them from Mexico, and I have to inform you that neither he nor I have found a single diseased potato amongst them. The crop has hitherto been considerably less than with our country potatoes, but are yearly improving; and I doubt not, that after being acclimatised, they may do well. They were planted last year in the field alongside, and treated in like manner with the others.

No. 28.—Mr John Findlay. Lyonston, 29th March 1846.

I had 10 acres of potatoes in one field, 5 acres of rough red dons, and 5 acres of cups, all growing luxuriantly—not a blank in any part. I observed nothing unusual in the state of the weather. However, about the 20th of August 1845, disease began to appear amongst my potatoes. It began with a small patch in the field about 15 or 20 yards square, the leaves blackening and curling a little about the edges, just as if they had been a little touched with frost—with this difference, that frost would only have affected the top leaves, whereas, in this case, those nearest the bottom of the stem were as much affected as those at the top. But in about 8 or 10 days the whole field was affected, and in the course of 3 or 4 weeks the leaves were entirely blackened. Whether this disease began in the stems and leaves, and communicated with the tubers, or whether it began in the tubers, and communicated to the stems and leaves I cannot determine. When I examined the tubers I found small black spots upon many of them, and they gradually grew worse, the spots sinking deeper in those already begun, and many more were affected.

2d, I am not aware of any of the varieties of potatoes commonly cultivated, that have escaped the disease altogether, my rough red dons were nearly an entire failure; when taken up there were 20 diseased ones for one sound; the cup kind were not nearly so bad, about one half of which were not diseased; the large potatoes were more diseased than the small ones. I believe there has been less disease amongst the early kinds than amongst the late; and potatoes recently obtained from seed have been just as liable to the disease as those long raised from sets or tubers. I believe no particular condition of the soil or kinds of manures have have had any influence in promoting, retarding, or preventing the disease. I may here state, that on another small farm of mine in a high cold situation, about 4 miles distant, I had 4 acres of potatoes of the red kind planted on land which I am certain there never had been any grain crop upon till I reclaimed it by draining. I cut drains 30 inches deep and 18 feet asunder, limed it on the sward, and allowed the lime to lie two years upon the sward before breaking it up. I took two excellent crops of oats, and planted the land with potatoes about the first week of May 1845; they grew well, had every appearance of an excellent crop, till about the last week of September, when they were attacked by the disease, and became so useless as to be scarce worth the raising.

3d, The best and most successful modes of storing potatoes, in my opinion, have been to lay them in houses, where such can be conveniently obtained, about 12 or 18 inches deep, and to pick and turn them over occasionally until they are dry. Another method which I adopted successfully, was to store them in very small pits, with a main drain-tile up the middle of the pit, and to cover the pit lightly with earth; or they would be much safer, and not so likely to rot, to be covered only with drawn straw, provided frost could be kept out; but in either case, if many diseased ones were put into the pit, they should be turned over occasionally, and the rotten ones taken away.

No. 29.—Mr James M'Kelvie, Overseer to Colonel Mure of Caldwell. Beith, 25th March 1846.

1st, The disease was not observable in this neighbourhood, except in two or three instances, till the beginning of October, when it was observed by brown spots on the tubers, under the skin; this was after very wet weather, and it was more generally observed after a day of very heavy rain which occurred about that time; the stem and leaves had all along appeared quite healthy. The two or three cases in which it was noticed earlier, the stems and leaves faded all of a sudden, some time in August, and the potatoes, when taken up afterwards for immediate use, were found not to keep good for more than a day or two.

Although there is less disease in the district than in most of those around us, none of the varieties have entirely escaped the disease. Those grown here for table use are the rough and the smooth reds, the rough whites, and the white dons, and the last of these are the least affected and the best preserved. There is a coarse watery variety cultivated in this district commonly called the Highland potato, and I have also been informed of a small parcel of a variety called "pay the rent," both of which have been little, if any, affected. I also know of several farmers having planted last season potatoes 3, 4, and 5 years raised from the seed, and they were in all cases as much affected as the rest of the crop; and I have observed that the later the potatoes were in planting, the lighter the crop; and where the soil was moss, the potatoes have been least affected and have kept best. I cannot say I have observed any difference with regard to the manure used, none being used in raising potatoes here but the dung of the farm, except in some cases when guano was used along with the dung, but this made no difference as to the soundness of the potatoes.

3d, The general mode employed here in storing the potatoes is in small pits, say 30 inches wide at bottom, covering them with straw and earth, turf and earth, or with earth alone, and in some cases the earth is thatched over with straw. The most common opinion seems to be, that the drier the potatoes have been kept they are the better preserved; but I have observed one or two instances in which they were better preserved with a little moisture in the pit, than where, in the same field, they were perfectly dry. Perhaps this was more owing to the want of ventilation, where they were so closely covered as to have received no moisture, than to any good from the damp itself, no openings for air having been left in the pits. I have also been informed of two farmers having each stored a few bolls in lofts, one of them amongst dry seeds from the mill, and both have found them better preserved than the same potatoes stored in pits, although dry.

I may further remark, that in two fields, where in a part of each the stems of the potatoes were early cut down by frost, the potatoes were much less affected with the disease than those in the other parts of the same fields.

No. 30.—Mr Alexander M'Caw. Ardlochan, 25th March 1846.

1st, In my opinion, the disease appeared on the lands which I possessed, in potatoes, in 1844, in the month of September, after a very heavy fall of rain from the east, with the same marked symptoms as in this season, although less severe in extent, the weather continuing more favourable after the attack than it was in the past season after its first appearance.

In the past season the disease began to show itself inland in the neighbourhood early in August on some of the finest lands, and made rapid progress after every fall of rain. It did not reach this part of the coast until much later in the season, when the crop was at maturity. On the lands which I possess, about the 16th October was the first symptom, by a small portion (about 1 rood) in a 30 acre field assuming a dingy brown colour, and this, after a heavy fall of rain from the east, similar to that of the preceding season. We had dry weather for some time after, during which the disease did not seem to extend, neither were the tubers upon the spot alluded to in the least affected; but after another heavy

fall of rain, in a day or so, the whole field assumed a withered or frosted appearance. We then examined the tubers, and found that the malady had fairly commenced the work of destruction, giving the potato attacked the same colour as that given to the stem and leaves—those tubers lying nearest to the stem in the middle of drill were worst, those more at the side (a 29 inch drill) and furthest removed from the stem, were nearly all free. We found the tendril which connects the stem and tuber, in all cases where the potato was sound, that it had not been infected near the tuber, but showed the disease to have gone so far along it. Where the potato was tainted, the tendril was diseased from the stem to its connexion with the root.

2d, All the varieties of potato cultivated by me in this and a field lying at a higher elevation of the farm, were more or less infected—those of the don kind suffered most severely, the cup sort least; and those four years raised from the seed (from America) as bad as any. The largest field, from two years' old lea, and another field, after the oat crop, were pretty much the same—the latter had never grown potatoes before;—a great portion of the whole was naturally dry, and a portion thoroughly drained. Upon the former, the disease was scarcely so bad, but with not much difference; the only exception were a few drills planted without manure of any sort, as a trial against those with dung and guano. They were a poor crop, with little stem, and were unaffected by the disease.

3d, My own potatoes, and those in the neighbourhood, have been generally stored in narrow pits, about 1 ton to 3 lineal yards, thatched over with straw. This has been found the best method here of storing. Those put into pits as usual, or into houses in large quantities, have suffered most.

I have been taking up a small quantity from drills that have stood the winter, from dry land well earthed up; they appear very healthy, at least it is easy to distinguish the sound from those tainted. The sound ones are sending out fine healthy shoots; those tainted, where more than one-half of the potato were entirely rotted, in many cases send out a stronger shoot, but very different in its appearance, and generally with a young potato upon its head. The rose or bud end is the last portion of the potato that decays under this disease, which makes its attack by the tendril in the opposite end. We did not find a single instance of those raised (for seed) to-day from the drill, where a diseased tuber had infected a healthy one.

3d, All infection, as I have said, appears to have been communicated from the stem by the tendril. From what I saw to-day in those we raised, I do not think that any more of the tubers had been infected since the malady had made its first appearance in autumn. Of course this confirms me in supposing the system of allowing the potatoes to remain in the ground during winter, and until the time to plant the new sets, is the best plan for the ensuing crop.

I had used lime to dry the potatoes before storing them into a house, but this was an entire failure. Those dried with ashes or dry sand kept better, but I do not think they are likely to prove so good for sets as those new taken from the ground. Frequent opening of the pits, and picking the bad potatoes from the good, have not had a better effect than leaving the whole together until now.

In correspondence with Messrs Drummond of Stirling, they advise me to plant for this season those potatoes intended for seed in the next, upon a piece of dry land in the flat way, (that is, not to bolster them up with earth;) to give no manure, and to allow them to remain in the ground until wanted for next crop. The crop in this way may be a small one, but it is reasonable to suppose it will be in a more healthy state than one forced by stimulating manures beyond what nature would do. This method is more likely to give the potato a sound constitution, and better fit it to withstand atmospheric influence. I have had correspondence with Mr Stewart of Dalhousie, Lower Canada, secretary to the Restigouche Agricultural Society there, who states, "that after heavy falls of rain their potato crop gave way with taint; that the only comparatively sound potatoes were those that had been planted upon the hill sides, where the water quickly drained off; and those which were prematurely frosted in the stems, or early taken from the ground, have remained quite sound." He further states, "that the awful ca-

lamity has elicited the fact, that there are potatoes indigenous to the soil to be found in some parts of the Restigouche in their native state; and that the society will encourage the cultivation of such in the hope of improving their quality, and producing a new generation of that most useful root."

No. 31.—Mr William M'Clive. Genoch, 23d March 1846.

The disease first manifested itself in this quarter in the latter end of September or the beginning of October. I make no doubt that it existed earlier; but the first time it was noticed was after a heavy flood which succeeded a tract of stormy weather. The first symptom I saw of the disease was a number of spots in the field, of an unhealthy yellow hue, the leaves being withered as if a dry scorching wind had passed over them and burned them up. There was at that time no symptom of rot in the potato itself, and scarcely any in the stem, with the exception of a small black spot at the junction of the stem with the ground. In a very short time, however, the disease extended to the roots or tubers, and then the usual appearances presented themselves of spots upon the end of the potato furthest from the stem, gradually extending over the whole, but penetrating inwards until the whole root became one mass of corruption. I may mention, that the spot mentioned as appearing in the stem presented exactly the same appearance as a carrot which a worm has penetrated.

Among all the varieties cultivated here, consisting of cups, red and white dons, Jerseys, and a kind called Connaught apples, the latter proved the best, the cups the next, and the dons and Jerseys the worst. They were principally cups and Connaughts that I grew myself, and of the latter I expect to have four-fifths fit for seed, while I have not succeeded in preserving more than one-third of the cups. I may mention, besides, that I had a quantity planted, of which the sets came from America, and they turned out as bad, if not worse, than the rest.

As a general rule, potatoes are not so much affected upon dry as upon wet land, nor so much with guano as farm-yard manure; but I think it is of no consequence whether the land has been previously cropped or not.

I had eight acres planted this year upon land which never had been green-cropped before, and they proved as bad as those grown upon land which had been in a regular course of cropping for years. A great many plans have been adopted in order to preserve them here, but none have been attended with any success except that of storing in lofts and granaries very airy and dry, and devoting constant attention to picking and turning them. It was found that they could not be preserved in pits, from the impossibility of keeping them dry. Some stored them in narrow pits well ventilated, but they continued to rot, in spite of every precaution; and, when not ventilated, they heated and grew. The best way of preserving them, when not put into lofts, has been to plough them well up, to protect them from the frost, and leave them in the field. I have left a considerable quantity in the field, and I find that they are no worse than when the others were raised. There was one way which succeeded, upon a small scale, which I only made an experiment of, but find it perfectly successful; but, like many other remedies, it is deficient in practicability: it consisted simply in enclosing them in an air-tight vessel, and expelling the common air by introducing carbonic acid gas, when the putrefaction necessarily stops for want of oxygen. This gas can be produced in great quantity, and at a trifling expense, from common charcoal, and although, as I said before, it could not be made available to any extent, yet to working-people I should think it would be easy for them to preserve their small quantity by means of it, should practice prove it to be really effectual; but I must confess that, although it succeeded the only time it was tried, I am by no means inclined to state it as an infallible preventive.

No. 32.—Mr Thomas Brown. Lanfine House, 23d April 1846.

Above the village of Galston, the valley extends along the Irvine for five or six miles; and, on each side, the country rises to an elevation of 900 or 1000

feet above the level of the sea. On the high ground, beyond this, there is a great extent of moorish high land, with a considerable part of it in cultivation; and, of course, there is a great variety in elevation, in exposure, and in soil. Along the Irvine, there are several manufacturing villages, which, independent of the landward districts, contain a population of nearly 7000 inhabitants. In all this district, from obvious causes, the potato is a favourite crop; and, in former seasons, with two or three exceptions, in spite of every variety in the weather, a disease of this description was not known.

In the season of 1844, one extensive instance of failure occurred in a field of 20 acres, forming a portion of the park of Loudoun Castle. This is a piece of flat ground, of excellent soil, which, in 1843, was broken up from old pasture, and produced a valuable crop of oats. In 1844, under the management of Captain Patrick, it was richly manured with guano, with farm-yard manure, and with other substances, and planted with potatoes of different varieties, but chiefly with the rough red and the don. The growth of the plant was very vigorous, the crop was large, and the quality of it, from the trials which were made, was supposed to be excellent. It was sold in the field by auction, in small lots, varying from two to six bolls, to a great number of the neighbouring weavers and other labourers, and, from the supposed superiority of the crop, at a high price. The potatoes were soon raised and stored, partly for immediate use, in houses, and partly, in small heaps, in the fields; but in all these divisions, amounting at least to a hundred, it was said that there was not any material difference in the result. The rot appeared in the rough red potatoes in about three weeks after they were raised, and in the dons in six weeks;—and soon after, from one-third to one-half of the crop was spoilt.

The disease had exactly the same appearance as that which prevailed so universally during the last season. This was minutely examined by various people, as well as by myself. In the early stages, the cuticle was loose; the substance, when cut up, was hard, with brown or livid brown spots or streaks; when boiled, it still remained hard, with an unpleasant taste and odour; if kept moist in the heap, after a short time, the diseased parts decayed, in the form of hollow irregular ulcers, with a disagreeable odour; but, if kept dry, they became shrivelled, and covered with white mould. After the disease appeared, attempts were made to sell these potatoes at Kilmarnock, but this was soon prohibited by the police. In a number of the stores in the fields, when examined, all the roots were found to be completely rotten. The rapid progress of the disease had not been watched.

Particular notice had been taken of this state of the potato crop at London Castle, in 1844. A similar disease, at the same time, materially injured a field of several acres, situated about two miles to the west of it. This was also holm land, on the river Irvine. I have not, however, heard of any other marks of it in this neighbourhood, during this season. In every other situation, the crop, in general, was abundant and good.

In the season of 1845, this disease, to a very great amount, has prevailed over all this district. It has been almost universal in the high country, but it has been more virulent in the low lands, near the villages on the Irvine. It is the universal opinion, that, *at the least*, from one-half to two-thirds of the crop has decayed. Soon after it was raised, different proportions of the diseased tubers could be safely, and were actually employed for food, or for the preparation of starch; but when the crop was allowed to remain in the ground, or when it was stored, the proportion which decayed was even much larger than has been stated. In many instances, early in the season, when the potatoes were stored, and when those stores were not attended to, they became heated, and were totally ruined. In a few elevated situations, in a peaty soil, there has been little, if any mark of the disease, but these were almost the only exceptions in this district.

Over the whole country, of course, there was well-founded alarm. The potatoes were decaying with such rapidity, that they were largely employed in feeding stock, or they were sent to the starch-mills, and sold at 4s. or 5s. the boll of 672 pounds. The result was, that the crop was nearly exhausted before the month of January.

Near my own house, at an elevation of 400 feet above the level of the sea, in a good well-drained soil, about 6 acres were planted with potatoes. Three acres were for my own use, consisting of 1 acre of cups, and 2 acres of dons, rough reds, and early varieties. The whole were greatly diseased, but the cups were not quite so bad as the rest. The remaining 3 acres belonged to the people around me, divided among five or six families. These were all fully worse than my own, and in two or three instances, the failure was nearly complete. The potatoes of small size were in general less affected than large ones.

The weather, after the month of June, was uncommonly unfavourable for vegetation. We had one night of decided frost about the end of June, and after that, till the end of the harvest, there was a constant succession of cloudy, rainy, cold weather. During the month of June, the stems of the potatoes were uncommonly vigorous, and apparently quite healthy, so much so as to attract the attention of all who examined them. It was remarkable, too, that there was a greater show of flowers, especially in the cups, than in common years. After the night of frost, however, and the unfavourable change in the weather, the appearance of the plant changed for the worse, especially in the flower. These fell off without producing any plums, and though I carefully looked over all the plants of the cups, I could not discover a single apple. There, were, however, a few on the other varieties. In the month of July, when the weather became unfavourable, there was not any sudden change in the foliage of the plant. It became, however, less vigorous, and on the leaves I discovered a few brown or blackish spots; but these were not numerous, or at all remarkable. It was noticed that the plant seemed to be ripe, and to decay about three weeks or a month before the usual period.

In many parts of the country it has been found that the crop of potatoes this year was a bulky one. In our district, certainly, this was not the case, as it was not nearly an average crop. The amount of grain, too, as well as that of potatoes, has with us, this year, been deficient and of inferior quality. I am informed by the millers that they have only from 13 to 15 pecks of meal from the boll of oats; whereas in common years they have from 15 to 17 pecks, or even more.

One remarkable circumstance connected with the crop of this year was the tendency to rapid decay. In former seasons, even in large heaps, although fermentation and increase of temperature may have taken place, yet, certainly, examples of putrefaction were rarely heard of. This year, however, small masses of potatoes, unless carefully watched and turned, speedily decayed. Even in those roots which were apparently sound, the vital principle seemed to be more than usually feeble.

Different plans were tried to preserve the crop. A large quantity, perhaps above 20 bolls of Kilmarnock measure (each weighing 672 pounds), were roughly picked of diseased roots, and, following the advice of the Commissioners for Ireland, they were moderately dried, by being spread, and turned, and exposed to the air for a day on a large paved court. About one-half of these were lodged in shallow heaps in two cellars. These were roomy, and kept well aired by open doors; and one of them had also an open window. The potatoes were carefully watched, turned, and picked. The sound ones, and those only partially spoiled, were used in the house, or for other purposes. Almost daily a number of dry, mouldy, or other potatoes were thrown to the dunghill. The whole stock was exhausted in January; whereas in common years they would have served without decay till the month of May, or even longer.

The remainder of these partially dried potatoes, instead of being stored in cellars, were formed into heaps on the surface in the open air; and to prevent the risk of heating, they were only two feet in breadth, and were covered with earth without any straw.*

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* In former years it was found, that in narrow stores of this size, covered with earth alone, the roots were much better preserved than in heaps of a greater breadth, covered with straw or turf, besides the earth.

These were formed into four divisions.

1. Contained the potatoes alone, as in common years.

2. In this the roots were carefully separated by sawdust, formed from foreign pine timber.

3. They were divided by moist peat-earth.

4. By powdered charcoal, also moist.

No. 1 became rapidly rotten; not one in 20 was preserved.

In No. 2, a moderate proportion was preserved; but less in No. 3, or No. 4. In these last, those roots which had been diseased before they were stored, of course became rotten; but as all these were separated by the peat-earth, or by the charcoal, from the sound ones, the decay or fermentation had not extended to them.

We were quite convinced that the plan of drying the roots before they were stored, as recommended by the Irish Commissioners, was decidedly injurious, since all treated in this way decayed more readily than those which were not dried. We may perhaps suppose that the removal of the moisture weakened the vital power, or, more probably, that the greater contact of atmospheric air produced a more rapid fermentation or putrefaction.

Another very simple plan was proposed by our overseer at Lanfine, and was tried by him with a boll of potatoes; and, undoubtedly, in this single experiment, the result was much more favourable than in the others. Whenever a basketful of potatoes, amounting nearly to a peck, was dug, it was loosely spread on the surface. These were covered and divided from each other by a few spadefuls of the soil in which they grew, so as to prevent them from coming in contact. Above this another layer of potatoes, alternating with one of earth, was placed, until the heap was about three feet thick in the middle, and sloping a little to the edges, so as to have a rounded form on its upper surface. In this experiment the breadth was about six feet. The earth on the surface of the heap was about two or three inches in thickness; and, with the intention of freely admitting the rain which fell, it was allowed to remain moderately loose. It was not beaten with a spade.

It was supposed that the potatoes would escape fermentation; and that, in this respect, they would resemble those which were allowed to remain in the drills, which unquestionably are better preserved, even in severe frost, than those which are accumulated in masses. It was the opinion of all who witnessed the single experiment, that it had been more successful in preserving the life of the entire potato, than the former plans: in fact, as much so as could happen with potatoes of which a proportion was diseased. There appeared to be one very decided superiority in the potatoes preserved in this way, viz., that their eyes continued sunk, or without growth; whereas, in the other plans, the shoots were one inch or more in length, and, in this respect, not suited for seed. In this want of growth in the eye, the potatoes covered with earth, after they are dug, resemble those which are allowed to remain in the drills through the winter; but the former has the advantage over the latter, that it allows the ground to be cultivated for another crop.

Besides these experiments in storing potatoes, we allowed nearly an acre of cups, with a few other varieties, to continue in the drills. We dug up every alternate row early in the season; but the quantity which remained in the ground amounted to nearly an acre. We passed a plough through the drills, so as to give a deeper covering to those which remained. This plan appeared to answer well in preserving that part of the crop which was free of the disease, and also in preventing the total decay of a small portion of the diseased roots.

About the middle of this month (a week ago) we raised these potatoes. From the whole acre we had only 5 bolls of sound and diseased roots, whereas in common seasons we should have had 20 or 30, or even more. Of the cups, only one half were quite sound; the other half were more or less ulcerated. A number of the ulcers were skinned over and healed. Of the rough red potato there was only a sixth part free of disease; and the diseased roots were so much hardened and blackened that they could not be used for poultry; they were, however, boiled with chaff, &c., for cows.

As there is sufficient reason to believe that these potatoes were fully better preserved in this way than if they had been stored according to the usual plans followed in common years, it shows to what an extreme the taint would have amounted. It had either totally or partially affected an excessive proportion of the crop. It may even be said that the absence of a severe frost, during last winter, rendered this experiment apparently more favourable than it would have been in more intense cold, and that we should not, in this case, have obtained even that small proportion in an entire state. But it is well known that keen frost does not destroy those potatoes which are moderately covered with the sod. If the freezing and thawing be gradual and slow, as takes place when the roots are moderately covered, they are not killed.

When the potatoes are, in this way, allowed to remain in the drill, or when, as in the experiment narrated, they are raised, and then stored, well separated by earth, we found that the eyes continued for a long time in a dormant state, and that, on this account, they were well preserved, either for food, or especially for seed. Perhaps we may be allowed to conjecture that, in this place, the moist earth, with which the roots are surrounded, may prevent the access of the oxygenous gas of the atmosphere, and, in this way, may retard vegetation or putrefaction; whereas, when the cuticle of the root is less cooled, as it is in a heap of potatoes managed in the common way, the air has more access, and, of course, more effect in producing these changes. On this principle, too, it is conceived that drying potatoes, as recommended in Ireland, by exposing them to the air, before being stored, is more likely to injure them than when they are covered up with earth immediately on being dug. From our own observations, unconnected with this idea, we believed that this was actually the case.

We have only heard of one instance, near this, in which potatoes were produced from the plum. A farmer produced a quantity of good mealy tubers by this plan two or three years ago. These were divided among several people. The plants produced last season were as much diseased as any other. This experiment, therefore, proves that raising from the seed will not remedy this disease.

It may be mentioned, that this season, on our own farm, it is intended chiefly to employ seed from districts free from this disease. We also mean to use a part of our own which seemed to be sound, and to form a few rows of those potatoes in which the disease was prevented, but in which the ulcers have been checked and cicatrised.

We propose to plant some potatoes on a poorer soil, or on a soil with less manure than formerly, and to reserve those for seed for the next season.

Before this last unfortunate year, the seed was generally placed in contact with the manure, which was previously laid in the drills; but this time, since it may have happened that their immediate contact was injurious, we mean either to mix the dung thoroughly with the soil, or to place a layer of earth between the dung and the soil.

We intend to prefer middling-sized or small potatoes, for seed, to those which are large; either planting the entire tuber, or only dividing it longitudinally into two parts, instead of a greater number, so as to have a portion of each end in each set.

If next summer be moderately good, we are induced to judge favourably regarding the prospect from the crop, since unquestionably, during last season, the uncommonly bad weather seemed to be the chief cause of the disease; at the same time, it must be allowed that the disease did exist in this, as well as in other climates, during former seasons. Surely, however, much benefit is to be expected from chemical and other science, when properly devoted to the subject.

I have only further to repeat, that this disease in the potato was unquestionably more calamitous, in this district of Ayrshire, than in most parts of Scotland. Even independent of the great loss of the crop, the constant attention required in the various necessary operations, by our labourers, detached them from their usual avocations, thereby of course incurring both trouble and expense.

In the parishes of Galston and Loudon only one instance occurred in which,

when the disease was distinctly present, the stem was cut over; and in this the benefit obtained was so remarkable that it is proper to relate it.

In the low flat fields, near the villages on the Irvine, the stems became spotted, and decayed early in the month of August, at least six or seven weeks before the usual period of decay, and when the roots were examined they were found to be diseased. In the higher country, however, this diseased change on the potato plant did not occur till some time near the middle of September.

Thomas Finlay, a small proprietor at Allantown Mill, on the upper part of the Irvine, near Loudon Hill, had a rood of potatoes (¼ acre) of the rough red variety. In September this, as well several neighbouring fields, became spotted, and began to decay. T. Finlay had heard that the disease appeared first in the stem and leaves, and from this reason he was induced to cut over all the stems of his potatoes close to the ground whenever the leaves became spotted, except one drill which was allowed to remain, in order that he might compare it with those which had been cut. The stems which were cut over, as we should expect, gave out a fluid or froth which moistened the ground an inch or two around each, but it was remarkable that this froth had a black tinge.

Some weeks after this, when the potatoes were dug, it was found that all the fields and patches around were decidedly and strongly affected, and it is remarkable that Finlay's drill which was allowed to remain uncut, was also equally diseased. The potatoes, however, the stems of which were cut over close to the ground, were entirely free of the complaint. They were dug and stored in the usual careless way in the corner of a loom-shop. Some of them were used for food, but the remainder were lately sold at a high price as superior seed. The account given is, that there were not six bad potatoes in the whole lot, and that they were the best-looking seed potatoes of any that had been purchased in this neighbourhood. The quantity of course was not large from a rood of land, but they were in perfect preservation, and were much valued from their sound appearance.

The facts connected with this single experiment were ascertained by the evidence of Finlay himself, as well as by that of two most respectable farmers living beside him.

BERWICKSHIRE.

No. 33.—Mr John Wilson. Cumledge, 17th March 1846.

So late as the end of September, I flattered myself, that in this immediate neighbourhood we were going to escape the malady, but, in the beginning of October, it began to show itself partially at first; and about the middle of the month, when the potatoes were generally lifted, it was found to prevail to a great extent, and had made rapid progress in the course of ten days. The stems were all broken down, by a tremendous storm of wind and rain from the north-east, about the middle of July; previous to which time they had been remarkably luxuriant, but never regained their growth, and began to shrivel from that time, and were completely withered long before the usual period of ripening. The tubers, when taken up in October, had streaks or layers of rottenness under the skin, like the appearance of a rotten apple, but were generally sound at the heart, though sometimes it was also affected. The black potatoes were all affected; some of the early white kinds a very little, and the Irish pinks scarcely at all. The early potatoes in the gardens are quite free, so far as I know. I am not aware that there has been any difference between those lately obtained from seed and those long raised from sets or tubers. The disease has equally prevailed in all kinds of soils, and under all the different modes of cultivation. Whenever the potatoes were stored or pitted in the usual way, that is, covered with straw and earth, they completely rotted, but when the pits were very lightly covered with earth, and ventilated along the bottom with drain tiles

or otherwise, or in any way exposed to the air so as the tubers became dry, the disease was stopped, or nearly so. I had all my pits opened about a month after the storing, and the diseased potatoes carefully picked out, and the sound ones re-pitted with a good covering of straw, and a very little light mossy earth over it, with which they have kept remarkably well, there being now very few diseased potatoes in any of the pits. I have allowed some to remain in the ground all winter—taking out every alternate drill, and covering the others well with earth with the plough. Those tainted in October have all gone, but the sound ones have kept exceedingly well, and are now less sprung than those in the pits. It is very difficult to come to any conclusion upon the subject; but so far as I am able to form an opinion, I think the disease has arisen from the cold wet summer—the earlier kinds that had arrived at greater maturity before the wet cold weather commenced in the middle of July having comparatively escaped, while those which were more tender have suffered the most.

No. 34.—Mr George Darling, Hetton House, Northumberland, March 17, 1846.

1. In the northern part of Northumberland the disease did not manifest itself before September, and subsequent to an extremely rapid change of weather. Cold weather, with constant showers, succeeded by three days of most oppressive and overpowering heat, which again were followed by extremely sharp frosts, immediately after which the leaves and stems were seen affected by blackish spots, which rapidly spread, and became, as it were, prematurely dead.

2. The variety called Irish cups suffered least in this neighbourhood; the kidneys most severely. I had one quarter of an acre of one and two year old seedlings; they were quite as much affected as the old varieties, indeed, many of them more so, and it was among them we first observed the disease. Wet soils and low situations were decidedly most severely affected, and in many places, *on high, gravelly, and sandy land*, no *perceptible loss* has been sustained, and much good seed is now available from such sources.

3. I adopted the following mode of storing—first, I placed all the best tubers in a shed, and covered them loosely over with straw, to protect them from any frost; they remained there two weeks, and being then quite dry, I put them in the usual way into pits, and find now that no further progress has been made by the disease. The damaged ones I left in an open place, slightly covered with straw, and consumed them, by steaming, for all my stock—cows, fatting cattle, store cattle, and pigs, and no bad result followed—the animals thriving remarkably well.

I planted a quantity of seed in November, as I have long been in the habit of doing, but this time I dusted the sets with quick lime. On examining the sets I now find the caustic quality of the lime has very much injured the skins of the sets, and appears to me to have had a bad effect. Still the eyes are pushing, and I do not fear for the crop.

My opinion is, that the peculiarity of the season was the cause of the disease, and unless we have a similar cold and variable one, with early frosts, I am not at all apprehensive for the year's crop.

I forgot to state, that a few bolls I raised for seed, previous to the hot days, were *all sound*.

No. 35.—Mr John Hogarth, Akeld, Northumberland, March 17, 1846.

I have thought it would convey my opinions more clearly, if I sent a schedule of my crop of potatoes, and then explain it—

No.	Kinds.	Manure per acre	Quantity per acre.	Quality.
1	Common yams or horse.	15 cwt. of rags.	15 bolls of 40 stones.	Free from disease, below an average size.
2	American early.	15 loads of farm-dung.	10 do. do.	Free from disease, below average size
3	Buffs.	15 loads of farm dung.	50 do. do.	Free from disease, average size.
4	Large white, we have no distinct name	15 loads of farm-dung.	60 do. do.	Free from disease, large size.

The soil was a light black gravel, incumbent on a moorband pan, being from 6 to 30 inches below the upper soil. The whole was subsoil-ploughed the previous winter.

The plants came well up, and were very promising, in every kind, until the middle of July, (15th or 16th, the usual term for earthing them up.) I then observed that the rooks recommenced their depredations, and that no watching would scare them away; and their attacks on Nos. 1 and 2 were most extraordinary, for, not content with the young potato, they carried off the old sets also, evidently a favourite food with them, as I frequently observed the potato left, while the set was carefully picked of every thing but the pith. A short time after the crows ceased from their visits, in the middle of August, the leaves and stalks began to wither, and had the appearance of having suffered from frost.

Nos. 3 and 4 were in no instance attacked, and retained their healthy appearance until the early part of October. It appears that the buffs and white kind have escaped disease, as far as my crop is concerned; and in adjacent farms, where the land in potatoes was of a similar quality, there was an uncommon crop of buffs. In another farm I found that the Irish cups were diseased, whereas, amongst my servants' portions, they were free. Whether to ascribe this to our breadth being subsoiled when my neighbours' was not, I am at a loss; but as the latter merely folded his sheep during the course of the winter, without applying any other manure, it may not be far from correct in ascribing the bad effects to the latter mode of management.

I had some potatoes raised directly from seed, grown in my garden, (being the second time planted,) entirely free from disease, and have kept well, having pushed their eyes in a healthy manner; whereas some American early, planted from sets which were screened by some rows of rasps, were uncommonly diseased, and unfit for storing. I cannot state how far previous cultivation has had any effect, further than that good cultivation is more likely to secure a good crop than the reverse; nor do I know that different manures were efficacious, further than by an increase of quantity; nor am I aware that wet soils were more subject to the disease than dry ones.

I have been all along of the opinion that the disease proceeded from some insect, which attacked particular kinds of potatoes more readily than others; and I am borne out in this opinion by my friends the rooks, who deprived me of diseased kinds, leaving me the healthy; and would recommend the delaying of earthing the drills up as long as possible, for, until that was done, we had no visits of importance. No doubt the larvæ of the insects were in the ground, but might not the stirring the ground bring them to a premature state of maturity, before the potato was in a state to resist their attacks? Look at the case of the turnip fly; if the seed is sown thick enough, there is such a rush of vegetation,

that the turnip soon becomes too strong for the enemy, and escapes its ravages. Why not the same with potatoes; either retard the progress of the disease, or increase the progress of the plant—the latter is easier accomplished. My mode of storing was in oblong pits, two and a half yards wide at the foundation, covered with straw, then earthed up the ends and sides, leaving an open space along the ridge of twelve or fifteen inches, covered merely with drawn straw. This, from experience, I have found successful with Swedish turnips, from October to June, and being alarmed at the continued reports of the disease, I resorted to the plan this season; other parts had no straw except along the ridge, for ventilation—this latter, I think, is most to be approved of, always supposing the potatoes are lifted in dry weather. For two years past I have used the small potatoes for seed; formerly my sets were invariably cut, and then fully impregnated with quick-lime. Whether this has caused an increase of disease or not, I am not competent to decide, but it is worthy of inquiry.

No. 36.—Mr William Hope Smith. Cruicksfield, Dunse, May 4, 1846.

Query 1st. In answer to this, the whole summer was unusually cold and wet; about the middle of September a smart frost for one or two days occurred, which blackened and destroyed the stems and leaves of all kinds of potatoes; previous to this the crop looked healthy, and I entertained no idea of taint having visited it till the middle of October, when I always store them, and discovered that in the same field, and under exactly similar influences and treatment, that the American early and Orkney red were perfectly free from any observable disease, while the black and don, as well as common white, were much affected. There were also some red, (common,) but only a few drills more injured than any of the others, and quite unfit for use.

Query 2d. The only variety which entirely escaped disease was the American early. A great proportion of the whole crop was raised from uncut potatoes, and manured as usual, (about 25 cart loads of farm-yard dung per acre.) The soil was in fine condition, a rather strong clay, and the field furrow-drained. I feel convinced that had the crop been raised earlier, (say three weeks,) less injury would have been sustained.

Query 3d. The Orkney red, though free from taint, was stored in the same pit, but separated from the others by a layer of straw; in ten days or a fortnight the whole heated, and I found that one half of all kinds were useless, with the exception of the American early, which were stored by themselves in a small pit, and have, up to the time of planting (a month ago) showed no symptoms of taint. On separating the bad from the sound, the latter were again stored in a pit ventilated by tiles, but the disease continued, and few were ultimately sound. The crop was a fair one, (being about forty bolls per acre,) and the good parts of the potato have been used for family consumption, and in appearance and taste were not inferior to former crops.

My intended practice for this season is, to store the potatoes in the beginning of October, in small pits, or even earlier, should the stems and leaves indicate sufficient maturity.

BUTESHIRE.

No. 37.—Mr John Paterson. Arran, 18th March 1846.

Being a reader of the *Gardeners' Chronicle and Agricultural Gazette*, my attention was early drawn to this disease, in consequence of the remarks made, and information given by Dr Lindley in that publication in respect to it. About the end of August I learned that the disease, as described by Dr Lindley, had appeared in the south end of Arran, in one or two places, but not to any considerable extent. The *shaws* (for such is the name given here to the foliage of the potato) turned brown and black—I may say in a night—and the roots at them were partially rotten, and both they and the shaws emitted a very dis-

agreeable odour. Still this was only partial, even in the places affected, and I advised the tenants to raise the diseased roots, with a view to prevent the spreading of the disease. This, however, had no preventive effect, as far as I observed, as in almost all directions the same appearance was seen in particular places, but very rarely over a whole field, though in patches here and there, and this in general among the red and white potatoes. Fully nine-tenths of the potatoes planted in this island, for a number of years past, were of the sort called *cups*, which came originally from Ireland. This sort, in general, long appeared unaffected, the shaws retaining their green colour especially on poor muirish, or sandy soils, and as there was almost no frost at the end of the season, if there had been no disease, they would have remained green much longer than they did. Towards the middle of October the shaws prematurely and suddenly became, first, a bright yellow colour, with black or dark brown spots, and then blackened and rotted. When the roots were dug up, they did not seem, in general, much diseased, and the people carefully separated the sound from such as were rotten. Having occasion, in the end of October, to travel from Ayr to Hamilton by Loudon Hill, Strathaven, &c., I examined the potato crop on the roadsides pretty minutely, and found that the disease, along the whole district, was very severe. The farmers, after lifting their potatoes, had pitted them in the usual manner. The weather was then, and had been for a considerable time, very wet. On examining several pits, I saw the potatoes in a rapid state of decay, in some cases half rotten, and in general covered with little groups of white or bluish points, like mouldiness. It then occurred to me that the potatoes were injured, and the progress of the disease accelerated, by being closely covered up, and when I returned to Arran, I warned the tenants there to beware of covering up their potatoes in close pits as usual, and recommended that they should be formed very small, and covered with rooty turf only, so that they could be examined from time to time, and the bad separated from the good. This plan was generally adopted here; and to it I ascribe the preservation of a considerable portion of the crop, for in several cases where the pits had been covered up in the usual way with straw and earth or turf and earth, the potatoes were generally found, early in winter, to be much decayed. When the pits are covered with turf only, the air circulates pretty freely among the potatoes, and ventilation is thus secured, perhaps as effectually as in any other way; at the same time, if severe frost had appeared, a temporary covering of straw or rushes would have been necessary, but there being very little frost here last winter, this was not required. There are now here very few potatoes in a state fit to be used in the kitchen, for domestic purposes, except the cups. The reds, dons, whites, &c. were much more diseased than the cups, so they were early used for food for cattle, pigs, &c., and those in a very bad state were sent to the starch-mill. The cups in general, though partially diseased, with brown spots here and there on the surface, are yet fit for use, and great quantities of this sort have been sold at Glasgow, Greenock, and on the Ayrshire coast, &c., at high prices.

I believe that in every sort of soil here the potatoes have been more or less diseased, but much more in strong clayey or loamy lands than in sandy, muirish, or mossy soils. Indeed in some parts of the muirs the disease has done little damage—and this was likewise the case there when the former disease of this root, (called here the *dry-rot,*) prevailed for a number of years, and did much more damage than the present disease has yet done. It is remarkable, that when the former disease prevailed, which it did for twelve or fifteen years, more or less, the finer sorts of potatoes appeared to have, in a great measure, lost the power of reproduction, and it was then found that the cups would grow and produce moderately when no other sort would do so. For two or three years before the last season, the dry-rot had mostly left us, and the better sorts of potatoes were again introduced into cultivation. The *cups*, though rather a harsh and strong-tasted potato, improves in spring and summer, and being by far the most hardy kind known here, will most likely be generally planted in Arran the ensuing season. It is not very productive, but will grow

tolerably on poor soil and with little manure. The manures used here in growing potatoes are ordinary stable-dung, sea-ware, and guano,—the latter in small quantities. The disease of the potatoes, as far as I have observed, has been little, if any, modified by any particular sort of manure. In fact it has shown itself under every sort of management here; but potatoes planted on strong manure, in large quantity, were generally most diseased. It is worthy of remark, that *the small potatoes, like pigeons' eggs or so, do not appear to be diseased*, and the tenants are preserving them for seed, to be planted whole. It was also observed, that under the former disease, those small potatoes which happened to be left in the ground when the rest were dug, grew well, and were often, after they appeared above ground, lifted and transplanted to fill vacancies in the drills.

As far as known to me, no potatoes immediately raised from the *bullets*, as the apples are called here, were planted in Arran last season. When the former disease prevailed, I raised several sorts from the apple, but by the time they were large enough for raising a crop, they were just as much diseased as the old ones. The weather during the end of last summer, and in autumn, was very wet, but I remarked nothing peculiar; and the foliage of the potatoes, so far as I observed, received no check, though there were some frosty mornings in summer. In Arran a great deal of rain falls, and I have often experienced much wetter and worse weather than in last season.

The crop of potatoes last year was extremely fine here, and there were no traces of the former disease. I understand, however, that in several places the present disease manifested itself in the crop of 1844; but it was ascribed to want of care, or other causes, and little thought of. Indeed, some say they observed a little of it in 1843.

As the existing disease has been often accurately described, and as it presents no peculiarities here, I think it unnecessary to trouble you with any description of mine; and the more especially, as it has been examined and reported on by skilful and scientific observers. We have tried no other plan of preserving this root than what I have already described, and it may be noticed, that wherever a large mass of potatoes were put together early after lifting, such as in a house or ship, the progress of the disease was most rapid; some cargoes sent to the Clyde in October being entirely lost.

Some fields of potatoes were left undug here, but it is very doubtful if this plan of preservation be better than putting the potatoes in very narrow pits, and covering them with turf in the manner some cottages are covered before the thatch is put on. The tenants here will likely, unless better advised, adopt this plan of making the pits this season; and no doubt trials will be made with powdery lime and other substances for preservation, but I cannot speak, from experience, as to the probable effects of such substances.

I may add, that the people of Arran have given the diseased potatoes freely to their cattle and pigs, and used them themselves, after cutting off the diseased parts, without any apparently bad effects.

CAITHNESS-SHIRE.

No. 38.—Mr Alexander Henderson. Stemster, 16th March 1846.

This county has hitherto been exempt from that disease which has affected the potato to so great an extent in other parts of the country. I am not aware that a single instance of it has occurred in Caithness; and, consequently, no difference in the customary management of that valuable root has been adopted in reference to it. Several cargoes of potatoes for seed have been exported.

No. 39.—Mr James Gregg. Harland, by Wick, 14th March 1846.

There are no diseased potatoes in Caithness-shire, as far as I have heard; and I believe *there are none*, as I have been making inquiry. There was a larger

crop than usual in this county; and it is computed that the average quantity on hand, in the county at present, is about one-fourth more than is usual at this period.

No. 40.—Mr Kenneth Macleay. Rosebank, Wick, March 17, 1846.

I am very thankful to be able to say that there has not been a single instance of the disease showing itself in this county (Caithness).

The potatoes throughout this county have been this year of very good quality, and the crop is an average one in point of quantity.

I understand that some shipments of potatoes have been lately made from Wick, with the view of being sold for seed.

DUMBARTONSHIRE.

No. 41.—Mr J. C. Colquhoun of Loch Longside, 14th March 1846.

On my small property on Loch Longside, I had planted last year, as usual, from two to three acres of potatoes of different varieties, early and late. Of these, the largest proportion were planted on a gently sloping bank, in light soil. The remainder, consisting of four varieties of early potatoes, and some late, were planted in the garden. All grew up vigorously; and I remarked that I never had, apparently, so fine a crop. As they approached maturity, however, I observed that, although the stems and leaves appeared strong and healthy, the flowers were less luxuriant, and what are called the plums considerably smaller in size, and less plump and fresh-looking than usual. When I began to use the early garden potatoes at table, I perceived that, although sound and of good size, in external appearance, they had a moist hardness at the heart, which I ascribed to imperfect boiling, and gave orders that they should be more thoroughly cooked. The particular state of the heart, however, still continuing, I began to suspect there was something wrong. In a very short time I perceived some dark spots outside, and, on removing the skin, observed that they penetrated into the inside of the tuber. At a subsequent period, I caused some of the late potatoes to be lifted, both from the garden and the field, and found them, in general, similarly affected, although some were apparently still sound. Having left the country about the beginning of October, I soon after received a letter intimating that the whole of my potatoes were infected with the disease, and that the crops of all the farmers and cotters in the neighbourhood were in the same situation. A few bags, however, of those least affected, were picked out and sent to me, which I used. Some of these exhibited little or no external marks of disease; but I perceived in all of them a slight and rather disagreeable *musty* flavour.

In attempting to account for this disease among the potatoes, I could not ascribe it, in my own case, to any of those causes to which it has been commonly attributed. Those planted in the garden had a sprinkling of guano, along with the other vegetables; those in the field had nothing but common manure. Both were equally attacked by the disease. In regard to moisture, I should say that last season was under the average upon Loch Longside. The temperature, I conceive, to have been about the average. In these respects I am not aware of any remarkable difference from other seasons. Considering the almost universal prevalence of the disease in question, in all countries and climes, and the absence of any definite special cause, I am disposed to view it as an *epidemic*, probably caused by some peculiar chemical or electrical state of the earth's atmosphere. My notion then is, that there are certain atmospheric *miasmata*, produced by causes hitherto unascertained, which, at particular times, affect animal or vegetable life with certain morbid tendencies—such as *cholera*, *typhus*, *murrain* among cattle, the *potato disease*, &c.; and that these affections spread from one country to another, independently of climate or other differences of situation and circumstances. Of this, *cholera*, as affecting the human race, is a remarkable example. Commencing in the eastern and southern regions of the globe, it spread to the western and northern, and left almost no country untouched. Medical gentlemen who are conversant with the history of epidemics, might probably be able to give many similar

examples. The *potato disease* itself, I believe, had prevailed in other countries (America for example) for some years before it was observed in Britain.

I cannot pretend to point out any cure for this distemper; no method, so far as I am aware, has succeeded, after the plants had become infected. Nor am I prepared to suggest any precautionary measures. Like other epidemics, the *potato disease* will probably wear itself out, or yield to more genial atmospheric influences. The great difficulty will be to procure sound potatoes for seed, and to this object, I humbly apprehend, the attention of the Society, in the mean time, ought to be principally directed.

Since writing the above, I have received a letter from the country, mentioning that some of the *calico* potatoes have kept pretty well, and are to be used for seed; and that the *cups* are still good, and are also to be planted.

No. 42.—Mr James Johnstone. Glennan, Helensburgh, 13th March 1846.

With regard to the first query. Up till about the end of August my crop of potatoes, which was a very large one, was more beautiful in appearance, and larger and better in quality, than any I have had for many years. The night before the day on which we first observed the shaws changed, was a smart frost; next day, the shaws, which the day before had appeared quite fresh and green, were mostly fallen and decayed; and, immediately afterwards, we observed at table, outside parts of the potatoes darkish coloured, and of a tough consistence. This appearance increased every day, till the usual extreme symptoms manifested themselves. The stems and leaves became of a dingy yellow, with dark brown spots; the same kind of spots appearing on the tubers on different sides, and gradually meeting and deepening, till the substance of the potato, in part or in whole, became putrid, fermenting with a sort of froth, and emitting a very offensive odour.

2d. We had three varieties of potatoes planted; early potatoes, reds, and cups. The reds were affected first, the early kinds next, and the cups last. The reds also were most affected, and the cups least. All our potatoes have always been raised from seed only. They were raised in a soil partly dry and partly wet, but we could observe no difference arising from that cause except in quantity; the tubers being more abundant in the former than the latter. We used no manure but byre and stable dung. In our immediate neighbourhood, however, on the Duke of Argyle's estate, a large crop, manured with guano, and which, in the beginning of August, presented the richest, most beautiful, and most plentiful appearance imaginable, was earlier and more utterly destroyed than any hereabouts.

3. We have stored our potatoes only in one way, in long narrow pits, about two feet broad, and two and a half deep, covered with earth and sods. How far this mode has been successful, may be inferred from the fact, that, in less than two months the pits fell in, and, on being opened, were found to contain only a mass of putrefaction and fermentation. Some of our neighbouring farmers have pitted them along with dry lime, which mode has been partially successful; others have left them in the ground, the result of which is, that about one-fifth has been saved.

We know of no means having been tried to prevent the extension of the taint from the diseased to the sound ones, further than storing the different varieties apart from each other.

No. 43.—Mr William Wallace. Auchinoole, 21st March 1846.

Answer to Query 1. One of the persons I have principally applied to for information is one who has been a great potato-farmer. He was the first in this neighbourhood who remarked the potato crop getting affected, and I think I cannot do better than give you this opinion of a practical person, and one who has devoted a good deal of attention to the subject. The person I allude to had about five acres of potatoes, one-half of which was planted upon a good dry sandy soil, the other half was on low ground along the side of Kelvin. One-half of the sandy field was set with buffs, and the other with reds. The buffs turned out a decided failure; not so the reds. He commenced digging the reds upon the 1st of August, and managed to dispose of about an acre of them, all good, before the 1st of September, before they showed any symptoms of disease. He left about a rood in the

ground with the intention of keeping them for seed; lifted them at the usual time, and pitted them; but found them rapidly decaying. Those on Kelvin side were very bad, and much flooded on account of the Kelvin overflowing its banks. In the first part of the season he was in the habit of frequently looking at the potatoes. Those potatoes that were pulled away from the stem, for the purpose of inspecting them, and again replaced in the ground, were keeping, whilst those around were decaying; but from the wetness of the season, and the frequent floodings over them, no further attention was paid to them; but he is of opinion, from what he saw, that the disease was communicated by the stem, and regrets he did not remove the stem as suggested in a paragraph which he read in the *Glasgow Herald*, quoted from a Dumfries paper. The first appearance of disease showed itself by the stem getting ruffled,—the extreme point of the blade or leaf became like a piece of half burnt paper, and rather of a lightish colour.

Answer to Query 2. All varieties of potatoes have failed to a certain extent; but the most to be avoided are the buffs. The red potatoes that were planted by the individual I have alluded to, grew on a field belonging to me—low-lying and of a stiff clayish nature. The same person who disposed of the above seed had about two acres of an adjoining field taken from me last season, which was partly cropped with potatoes. They are keeping better than any in this neighbourhood; so much so, that he is keeping them for seed. He was rather late in planting them. They were manured with about 20 tons good of Glasgow ash manure, and 4 cwts. of Peruvian guano, per acre. The crop was not a heavy one, and the potatoes rather small in size. The ground where they grew upon is low-lying, was drained a couple of years ago, and had never been green-cropped before in the memory of man. I would have been disposed to have attributed the above exemption from disease, to the ground never having been green-cropped,—if it was not that I know of a field in this neighbourhood that has not been green-cropped for at least twenty years. The field stands high, soil dry and good, and the kind of potatoes planted were the cups. I saw them when growing, and finer-looking potatoes I should not wish to see; but the parts of the fields where they looked best and strongest, were the most affected. I understand the loss upon them is about a half.

Answer to Query 3. A good deal of potatoes were sent to the mill. The rest were generally pitted in the usual way, only in smaller bins. Having only a few bolls of my own, I was more particular. I put them into a shed, had them dusted over with lime, kept them under cover for some days, so that they were consequently dry before pitting them; but all my precautions were unavailing, as the disease spread, and I have lost more than half of them.

No. 44.—Mr Montgomery, gardener to the Duke of Montrose at Buchanan. 17th March 1846.

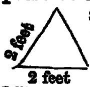
My opinion is, if the disease was produced by the chilly season of last year, or atmospheric influence, a more genial state of the air will prove, in all probability, its cure. But if the disease is from other causes, such as by long continued cultivation exhausting the vital energy of the potato, and getting into a cankerous state, failing to produce healthy tubers, such would render a cure hopeless in the present stock. The only sure way to regenerate the potato is to get seed from where there has been no disease, and raise a new supply of good tubers for cultivation.

1st, It is inquired at what period of the season the disease appeared? It showed itself first on the leaf of the potato, in circular spots, in the beginning of August, in some situations later, and soon after gave the plants the appearance of premature ripeness, and in September the tubers became partially affected, which increased very rapidly after, particularly in the cottagers' gardens where the crop was most luxuriant.

2d, It is inquired of the sorts of potato, and if differently affected? In this quarter the red potato is least affected; the potatoes grown in wet or highly cultivated land were most injured with the disease. Those grown on high poor muirland least tainted. All the sorts are grown from sets, no instance here of any being raised from seed. And with the exception of three or four farms in the west of

Stirlingshire, the disease is very general, and where the potatoes were stored in the usual quantities the disease increased much. It is found where the ground was favourable for allowing them to remain in the drill they have kept best.

3d. The usual method of storing potatoes, is the common practice here, but to preserve the tubers sound, the pits should not exceed two feet on the surface, thus,



and stored dry. If damp at the time of storing, dust them with lime, which will prevent the disease extending from the tainted to the healthy tubers. I may state here the circumstances of two farms belonging to his Grace the Duke of Montrose, near Gartmore, where potatoes were grown upon a hill, those on the south side belonging to one farm having a considerable slope to the sun, and on the other side of the hill a similar slope to the north, the land dry on both sides, and very similar in every respect—the same potatoes being used by both farmers. The crop sloping to the sun were all diseased; while those to the north are almost free of taint.

From the south, the accounts of early produce of potatoes are very discouraging, even although no appearance of disease could be seen in the potato used for seed. The young tubers became very early affected; and in many places the plants appeared for a time healthy and luxuriant, but as soon as attacked by this destructive malady, changed their appearance from a healthy to a sickly state, and became a failure.

This potato disease very justly has excited much interest every where, and many conflicting opinions are given, but nothing is stated as a certain cure. From the first appearance of the malady I considered that raising a stock of potatoes from healthy seed to be the only sure way of getting quit of the disease.

DUMFRIES-SHIRE.

No. 45.—Mr Robert Elliot. Hardgrave, 13th March 1846.

1st, The disease first made its appearance about the end of July, and in a very few places about the middle of August, when it became general on all early soils, and universal by the middle of September. In my opinion, the disease manifested itself more in proportion to the state of ripeness or forwardness of the potato crop than from the state of the weather; the general character of last summer being, with the exception of a fortnight in June, which was clear sunshine and hot beyond all former experience for the season—dull hazy weather, not much rain or actual wet, but dull damp weather. The general appearance presented by the plant, when the disease was first observed, was a discoloration of the leaves, giving the field the appearance as if it had been frost-bitten, the leaves, in a few days afterwards becoming, when rubbed between the fingers, like brown snuff; the stems next appeared affected, becoming, instead of green, bleached and withered, and, upon examining their interior, in nine cases out of ten, I found the heart of the stem as if eaten by insects. The flowers withered immediately after the leaf decayed, but in general the plums were formed before the disease showed itself. The appearance of the tubers, after the taint had extended itself to them, was in small spots of a brownish colour, not much deeper than the skin, which gradually spread over the whole surface, the potato becoming, immediately afterwards, like in appearance to an apple which has fallen from a tree and become rotten among the grass.

2d, The variety called second early, appears in this district to have almost entirely escaped the disease; prince regents, cups, Lothian blues, and Highland chiefs, appear to be much less affected than Highland early, or any of the finer varieties of table potatoes; indeed, it may be stated as a general rule, that all late and coarser varieties are less affected than early or finer kinds, with the exception of the second early, which is both an early kind, and a good table potato.

Potatoes recently raised from seed do not appear to have escaped the disease, or to have been less subject to it than those which have been long raised from sets or tubers. The particular condition of the soil, as regards wetness or previous cultivation, or the kinds of manure used, have not prevented the disease; in fact, the disease first showed itself in the driest and earliest part of the fields; and in furrow-drained land it generally showed itself first on the top and along the line of drains;

and as regards manure, *all manures which bring the plant first to maturity* were the places where the disease showed itself, such as stable manure; while those planted with guano or bones were longer in being affected; although in the end wet land, land manured with guano, bones, or any kind of manure, all became affected. This observation applies also to the different varieties, those which have strong healthy stems, and were longest in showing signs of the disease, but in the end became generally affected before being raised.

3d. The modes employed in storing potatoes have been various in the extreme, some have stored them in the ordinary method, covering them with earth, (too many;) others put ventilators through the pits, of every form and description; others put them in narrow pits, covering only with straw; others stored in granaries, laying them about a foot thick; while some stored them in pits, mixing them with lime, dry sand, sawdust, &c.

My experience teaches me that the worst way of preserving them is to store them wet, and cover them with earth; and that a good way is to dry them well before storing, and lay them in narrow heaps covered only with straw—turf or earth preventing a free circulation of air;—or a better mode still, when it can be done, is laying them in granaries about a foot or 18 inches deep, and turning them over till they were dried. When this was done, I believe they did not become worse; those already affected might rot and decay, but the disease did not spread itself.

I may mention one fact which came under my own observation—I had nearly 100 tons stored in various ways, mostly in narrow pits, with a covering of straw. One of the pits, in a windy day, seemed as if the straw would blow off; when one of the men working at them laid a shovelful of earth here and there upon the straw to prevent its blowing away. Upon examining the pit about a week after, the potatoes below the parts where the shovelsful of earth were laid appeared rapidly going to decay. I had them removed immediately, when the potatoes seemed much better in the course of a day or two. I am convinced, from my experience, that dryness and a free circulation of air, the potato at the same time being covered, is indispensable in storing potatoes affected with this disease. I saw a lot of potatoes raised last week in mossy soil, having been left all winter in the drill, and they seemed very fresh, and in capital condition. Some I had in moss kept well, while those on dry croft land did not keep well.

I trust sincerely that your efforts will be crowned with success in discovering at least some mode of mitigating the evil, should this disease unfortunately again show itself; and whether or not, I hope that it will already have taught us this lesson, that we should not now depend upon potatoes as the sole food of any portion of the people. I am strongly impressed, however, with the belief that the disease is caused by atmospheric influence, and not by the plant having become degenerated; and I trust that the disease will be as temporary as it has been sudden and unexpected. I am strengthened in this belief by the potato plant having been in general, through the early part of last summer, healthy and vigorous beyond the experience of a number of years previous; and also from the disease having spread itself like an epidemic over a great portion of Europe in the same year, which are not the modes one would have expected such a disease to have shown itself, had it originated in the potato having become gradually degenerated.

In examining the stems in the early stage of the disease, I observed at the heart a vast number of small black insects, so small as with difficulty to be observed by the naked eye, and which were in a dense body in thousands, eating the heart of the stem. On applying a microscope, I observed they had two horns like a black snail, a number of legs on each side, very like a wood-louse; and, upon bringing them upon a piece of white paper, they leaped an inch high by three inches in distance. Upon looking for them again a month after, I could not see one; but the hearts were eaten out of the stems, and at a distance of about an inch and a half from each other were placed small black balls not larger than a pea—black on the outside, white within, tough, and they cut like a piece of orange skin; and what I regarded as curious, these balls were generally in pairs, one a little less than the other, as a residue left by the insects. About a month after the insects had all gone; upon examining the stems, they had left their skins apparently behind them, as if they had cast them, and become the fly or some other state. Whether these insects had any thing to do with the disease or not, is a question I

do not feel myself competent to answer, for perhaps they were simply devouring already decayed matter, as it seems a wonderful provision of nature that nothing shall go to waste, and that no sooner decaying matter presents itself than animals spring up, as it were, in an instant, and feed upon it. I only mention the fact of the existence of insects, in case of the recurrence of the disease, it might be well to watch the time these insects first make their appearance. I am strongly impressed with the belief that the disease was caused by some blight upon the leaf, which, ceasing to perform its functions, caused the potato to retain within it juices which, if the leaf had remained healthy, it would have emitted; but which remaining as it were stagnant in the potato, caused it to rot and decay. I was strengthened in this belief by seeing the potatoes which were lying exposed and green on one side, did not suffer much from the disease, possibly exposure to the air giving them the power to emit those prejudicial juices. This, however, I freely admit is pure conjecture, and only thrown out as a hint.

No. 46.—Mr Alexr. Stevenson. Langholm, 20th March 1846.

1st, The disease appeared in the beginning of August 1845. After very wet and cold weather, the stems, leaves, and flowers withered and shrivelled. As the taint extended, the tubers became more or less affected over the whole crop.

2d, The second early and Irish cups have in a great measure escaped the disease. None have been raised from the seed in this district for a long while. Wet soils and rich manures have had considerable influence in generating or promoting the disease.

3d, The modes have been various, such as pitting them in the usual way, or dusting over with lime, or leaving them in the ground during the winter covered with an additional furrow of earth. Under all these modes the disease seems still to extend itself, and no absolute preventive has yet been discovered.

Not considering myself a sufficiently practical agriculturist, I cannot presume to give an opinion relative to the operations and success of the means that should be employed for retarding or preventing this disease.

No. 47.—Mr Robert Hewitson. Auchenbenzie, 20th March 1846.

1st, The disease was first observed about the middle of September. The season generally was wet; but, at that time, was comparatively dry. In consequence of two nights of severe frost, the leaves and stems had previously fallen. When the tubers were first observed to be tainted, they were marked with spots of a livid hue.

2d, Last season I planted chiefly one variety of potatoes—the buffs. On the farm of Auchenbenzie, they were planted on a field which was newly broken up and dry, and were extensively diseased. On the farm of Drumbuie, they were planted on newly broken-up mossy soil, and were almost wholly free from disease. The potatoes planted on both farms were buffs, and, in the previous season, had grown on the latter farm, and been kept there till seed-time. The manure used was wholly farm-yard dung. Neither of the fields had grown potatoes before.

3d, Separating the sound from the unsound portion, drying, and keeping dry. However, after all the care bestowed, the potatoes on the farm of Auchenbenzie have gradually become more diseased, until now, out of 150 cart loads, I have not more than 2, and even this small quantity, I am afraid, will be unfit for seed.

No. 48.—Mr J. L. Russell, Secretary to the Nithsdale Agricultural Society. May 1846,

1st, I have no precise information that can be valuable in regard to this query. The disease appeared generally in the beginning of September, though it was observed, in some cases, as early as July. The general impression is, that the taint first affected the leaves and stem, and subsequently descended to the tubers. The disease was first observed in patches in the potato fields, blackened as if from frost.

2d, The varieties that have been least affected, as far as I can ascertain, are the *sleepers*, *Irish blackguards*, and *cups;* to these must be added all the very early kinds. A general rule seems to hold, that the disease has made least progress,

where, on the one hand, the tuber attained to maturity early in the season, or, on the other, where the stem continued to grow vigorously till a late period. Of this latter kind are the *sleepers*, which seem entirely to have escaped the taint, as far as I can discover, and I have been careful in my inquiries, and have personally examined samples. This is a large round potato with deep eyes, and marked with spots of scattered red. It seems to have been introduced into this district from Ayrshire, and has the character of being a coarse potato for the table. One gentleman had several varieties of seedlings which he cultivated with much care; and they were all affected with the taint. The disease has prevailed in every soil, and no manure seems to have had an influence in warding it off Certainly, there is an impression with many in this quarter, that *mossy* or *muirland* soils have been the least favourable to the progress of the disease.

3d, In Dumfries-shire, potatoes are usually stored in pits in the field, or in some convenient corner near the farm-steading. This last season the farmer was anxious to store as great a quantity within doors as he had house-room for, but, necessarily, the greater part was put up in *pits* (more correctly heaps), covered with straw and earth. Considerable patches over this district were left undug, and allowed to remain in the ground over winter. All the means recommended in the public prints were tried—such as *lime, chloride of lime, ventilation, and careful exclusion of the atmosphere*, &c. The result of the whole, I believe, is this, that no man has preserved his crop better than he who carefully dried the tubers at first, kept them dry, and frequently hand-picked them for the purpose of removing the diseased ones In those cases where the potatoes were left undug during winter they are considered, where the soil was dry, to have been preserved as well as in any other way.

ELGIN AND MORAY SHIRES.

No. 49.—Mr Alex. Mackintosh of Mackintosh. Dalvey, Forres, 14th March 1846.

My reply will be a very brief one, in consequence of not having on my ground, or on any farm on my property, any diseased potatoes.

In the cutting for seed, planting, training, and housing, I observed the usual means and precautions, with the single exception of putting furze into each heap last autumn as in any previous year, and this I attended to in consequence of the unusual degree of humidity which I, in common with all others in this county, experienced. The result of such a precaution is, that I have not a single diseased or unsound potato in my store.

As to the nature of the disease, or its premonitory symptoms, I believe it is out of the power of any agriculturist to say what it originates in, or what the auxiliary second cause may be. That extraordinary dampness, whilst in growth, may affect the tuber, I have no sort of doubt; and to guard against the danger of loss, I would recommend diminished quantities to be put into pits, to prevent decomposition arising from softness and pressure.

I may here say, my rule is, to dig a pit one foot deep, cover the potato-heap with straw, divots, and some earth, say one foot in thickness, against frost, having a vent in the top of the heap. Deep pitting I am decidedly against, for heating is a consequence, and from the absence of air, rapid vegetation commences, which, of course, deteriorates the character of the tuber; whereas, in the pit I make, there is sufficient air passing through it to delay growth.

In fine, I think the disease of the potato has nothing to do with the wet season of last year. It is one of those visitations we must experience, and which no power of man can avert.

No. 50. Mr Alex. Brown, Secretary to the Morayshire Farmer's Club. Elgin, 14th March 1846.

We know nothing whatever of the disease in this county; had a beautiful crop; and have not heard a complaint of any thing having happened in the pits.

No. 51.—Mr Robert Mitchell. Darnaway, 16th March 1846.

In answer to the first two queries, I have the satisfaction to state, that no such thing as the disease complained of has ever occurred under my observation, and I have seldom had any failure; and when any did occur, it was chiefly when we were short of properly decomposed manure, and had recourse to fresh dung out of the fold—a practice which I now endeavour altogether to avoid.

Our last crop was a full average, without one diseased potato; and, in taking some of them out of the pits the other day, I find that there is not a single tainted one among them. I have no potatoes recently obtained from seeds, but for some time back I have every year got a change of seed from the higher districts, which I find to answer well. My method is, to plant as early as possible; to have the dung put out to the field in the beginning of winter, in order that it may get properly decomposed, or rotten, which is done by mixing with earth, or scrapings of roads, &c. and turning twice or thrice properly. The oftener the dung is turned, I find the potatoes thrive the better.

I have never used any ventilators in the pits. I just cover them with a quantity of dry straw, with a slight covering of earth for some days, after which I have them properly finished with earth for the season.

I may mention, that, taking this district generally, there has been no disease last year, nor have I, as yet, heard of any thing wrong appearing in the pits, but many people complain of their crop being below an average.

No. 52.—Mr James Geddes. Orbliston, 16th March 1846.

I am happy to say, that though a considerable grower of potatoes, I can give you no information relative to the disease, it being entirely unknown in this quarter, so far as I am aware. I may mention that our soil and subsoil are particularly dry, generally speaking, and that we have less rain here than in any other part of Scotland.

No. 53.—Mr Alex. Colvin. Earlsmill, 31st March 1846.

In reply, I beg to state that the disease has not, fortunately, made its appearance in this quarter. Our last crop was abundant; and as a proof of its healthiness, I may mention that the Earl of Moray caused a large quantity of potatoes to be sent from this and the neighbouring district for seed to his tenants in Fife and Perthshires.

There have also been large shipments for the south from the different ports on both sides of the Moray Frith during the season; and notwithstanding the large exportation, the price has fallen from 60s. to about 55s. per ton, and in some instances as low as 52s.

I consider early planting and well decomposed manure as the best preventives against failure in the field.

EDINBURGHSHIRE.

No. 54.—Mr John Dodds, Factor to the Earl of Stair at Oxenford.
Cranston Cottage, 13th March 1846.

I am happy to say that the queries are easily answered, in as far as regards the crop of potatoes grown on Lord Stair's farm at Oxenford. His Lordship had about twelve acres, consisting of cups, dons, buffs, old blues, and Perth reds, and neither of the kinds have been affected by the disease. The crop was not a heavy one—not quite 30 bolls of four cwt. per acre. I may mention that great care was taken to store them dry, and in pits *on the surface* of the ground, about three feet wide at the bottom, and tapering to a point, about three feet high. They were only covered with straw, with a spading of earth about nine inches deep from the bottom, to keep the straw secure. This spading was taken out of each side, close to the pit, and thus formed an open drain to carry off the water.

The potatoes that are yet unused are perfectly sound.

There are not many potatoes grown in this neigbbourhood, except for private use; and, generally speaking, there has been little or no disease of any consequence; indeed, I do not think there has been more loss than in former years. Any of the crops I have seen did not appear to be affected by what has been termed the "potato murrain," which I had observed to prevail in other quarters.

No. 55.—Mr Alex. Tod. Easter Road, Edinburgh, 16th March 1846.

Answer to Question 1st.—Not having had any failure in my own potato crop, and having had little opportunity of observing the country generally, I am not prepared to state the exact period at which the disease manifested itself, or the symptoms which accompanied it.

Answer to Question 2d.—I am not aware that any variety has been generally less affected with the disease than others; for both among those that have been affected, and those which have not, all varieties will be found, and that even on the same farm. The varieties recently raised from seed have not escaped the disease. As far as I can learn, on long and highly-cultivated fields the disease was most felt; but I do not think that it was either promoted or lessened by any particular kind of manure. I think much depends on the manner of applying the manure to the potato crop, so as to promote a steady, healthy growth throughout the growing season. On land that has been long under cultivation, the dung should be put in during the winter months, that it may be properly amalgamated with the soil by the planting season.

Answer to Question 3d.—The manner of storing has generally been in pits, and made up as in former years; but in some instances the potatoes have been covered merely with straw, and in a few others stored in ventilated pits. The last mentioned mode I consider is the best for preserving potatoes, and preventing the disease communicating; and the plan I would recommend for a ventilated pit is, to have it in a dry airy situation, standing east and west, of a breadth commonly in use, and of depth not more than three or four feet; a line of the largest drain tiles, placed two inches apart, to run up the centre from end to end, and to be open at the ends; and if the pit is long, to have cross lines of tiles on the same plan; the ventilators to be placed ten or twelve feet apart, resting on the tiles, and sparred, except that part which rises above the pit, and which must be close at the sides, so that the ventilators might easily be shut when necessary. These means, namely, the lines of tiles, and the sparred ventilators, will supply the pit with regular currents of fresh air, which will dry the potatoes, and prevent fermentation.

No. 56.—Mr James Hunter. Newliston Haugh, 14th March 1846.

1st, In answer to the first question concerning the potato disease, I am sorry to say that I can give you no information, having paid no attention to it until we began to lift them. 2d, I find that none of the varieties have escaped the disease; but that the common don has been far less affected than any of the others. The different soils or manures appear to have had no influence in promoting or retarding the disease; but where the crop was most bulky the disease was most prevalent. 3d, The mode I have employed in storing the potatoes, is to put them into small pits, about 2½ feet wide, covered with a considerable quantity of straw, and no earth.

No. 57.—Mr Alexr. Scott. Craiglockhart, by Slateford, 16th March 1846.

In answer to these queries, I may state, that I have been a potato grower for 25 years, the quantity I annually grow being from 45 to 50 acres, and consequently have taken an interest in the various diseases which have affected the potato crops of late years. The peculiar disease of the present season I consider to be perfectly distinct from that of the curl; and I believe in general it will be found that potatoes affected by curl will be found less affected by this disease than others, not in consequence *a priori* of their being curled, but for other reasons which will

afterwards be alluded to. I however mention this, as it is a matter to be taken into consideration, and guarded against in the selection of seed; as parties selecting seed now, and who have not had an opportunity of seeing them growing (which is the only time when curled potatoes can be detected) may be induced to purchase them, because of their freedom from the peculiar disease of the season.

The first appearance of the disease observed on my own farm was about the 18th of September, at which time it was exceedingly trifling, and probably would not have been detected, had not our attention been directed to the subject by the reports from the south. However, after a little practice, the few plants which were diseased were readily recognised by the premature drooping of the leaves. The disease continued of the same limited character until the 3d of October; on which and on the following day, we had one of the heaviest falls of rain experienced during the season.

We commenced lifting potatoes for the Edinburgh market on the 21st of August, and up to the 6th of October had not a single complaint as to their quality. Those lifted on the 2d gave perfect satisfaction, but owing to the quantity of rain which fell on the 3d and 4th we were prevented lifting until the 6th, when, of those lifted on that day, one third were diseased, while those that remained in the ground, where the crop had been previously lifted, were perfectly sound when the land was ploughed for wheat in the beginning of November.

Immediately after the 4th of October, the potato fields universally presented an appearance of premature decay—not such as is occasioned by frost, which causes the leaves to turn brown, become crisp and fall off, nor such as is occasioned by ripening, when the leaves gradually become yellow, then brown, and fall off,—but the leaves became flaccid, hung lifelessly down, became brown, but still adhered to the stems. Both diseased and sound tubers were found at the same stem; and the disease was not confined to any particular part of the tuber, some being diseased at one end, and some at the other; but where diseased, they externally presented a a glossy leaden-coloured appearance; the epidermis in the first instance was not injured, but immediately beneath it the diseased part presented the same appearance as that of a bruised apple, or over ripened pear, the depth of the disease varying from the eighth of an inch to the centre of the potato.

The varieties I had in cultivation were buffs, cups, and red potatoes, a portion of which red potatoes I had grown on the farm the previous year, having obtained the seed from Shetland in spring 1844, and another portion of the same kind of red potatoes obtained from the same district in spring 1845. There was little or no difference in the extent of disease amongst the buffs, cups, and the reds, which had been twice planted; but the reds, the seed of which I had obtained from Shetland in 1845, almost entirely escaped, and they retained their green appearance until lifted. They were grown in the same field with the buffs and cups, and treated in every respect alike.

I have no personal experience of potatoes recently obtained from seed; but I have reason to believe that no difference has been found in respect to them. I am decidedly of opinion, both from my own experience, and information obtained from others in various parts of the country, that no effect can be attributed to any particular condition of the soil as regards wetness, previous cultivation, or the kinds of manure used; but I have uniformly found that, where the circulation of air has been least, arising either from local situation, influence of trees, or luxuriance of stems, there the disease has been most severely felt; and I have no doubt that the comparative escape from disease of curled potatoes, and other light crops deficient in stems, may be attributed to the freer circulation of air amongst them; at the same time, the disease has been most erratic in its attacks, portions of the same field, apparently in every respect alike, having almost wholly escaped, while those around suffered severely.

Were I to hazard an opinion as to its cause, I should say it was miasmatic in its nature, which was accelerated by the excessive moisture of the tubers; for although experiments have been made to show that sound potatoes of this year contained as much water as diseased ones, I hold that these experiments are not conclusive. The experiments ought to have shown the comparative quantity of water in this year's potatoes, and those of former seasons. I am also decidedly of opinion that the fungi are a consequence, and not a cause of the disease; and although I am aware that large quantities of potatoes have been lost by heating in houses and pits

and in this way have lost a quantity myself, I am not aware that the disease in any instance has been communicated from a diseased to a sound potato. With a view to test this, I selected six of the most diseased ones, which I cut in two pieces, and having taken an equal number of sound ones from the same pit, and treated them in the same manner, I applied the cut half of the diseased to the cut half of the sound ones, bound them together and kept them so for fourteen days, during which time the disease was not communicated from the one to the other.

My ordinary mode of storing the crop was to put as many as I could into the potato house, which is 18 feet wide and 40 feet long, and laying them up to the depth of 7 or 8 feet; the remainder I stored in pits 5 feet wide, containing about 12 cwt. to the lineal yard. Those in the house were generally removed by the middle of December, and in this way they kept in perfect safety. This season, however, I limited the depth in the house to 5 feet, and only put in as many as I conceived would be removed in the course of the month. The remainder I put into pits 3½ feet wide, some of which were covered in the usual manner with straw and earth, packing in drain tiles both below and above for ventilation. Others were turned over in the pits and mixed with hot lime, and then covered with straw and earth, and ventilated. Another portion, after being mixed with lime, were covered with straw only, and a further portion were allowed to remain as pitted from the field, without being mixed with lime, and covered with straw only.

I soon found those in the house heating with great rapidity, in consequence of which part of them were completely destroyed. All the pits covered with earth, however well ventilated, also showed a disposition to heat; the earth was therefore removed, and they were covered with straw only. The lime I found to do neither good nor harm, the expense of which, and the labour of turning, may therefore be considered as so much lost.

The mode which I found answer best was storing in small pits, and covering with straw alone, to the depth of a foot, thatched and roped in the same manner as a stack.

The result of my management was, that between the 6th of October and 1st of March I sent to Edinburgh 1300 bolls of good marketable potatoes, from which I picked out an equal quantity of diseased ones, of which about 300 bolls were only fit for the dunghill. the remainder were either sold at a low price for feeding cattle, or used at home for that purpose, and feeding horses; having kept 19 head of cattle for four months exclusively on diseased potatoes, and fed 17 horses for the same time on them, boiled and mixed with a few yellow turnips.

I may also mention, that I had potatoes grown with 13 different kinds of special manures, but to none of these could I trace any effect as regards the disease—the disease being always most severe where the dew lay longest, from a want of circulation of air.

No. 58.—Mr Andrew Gibson. Dean Park, 22d March 1846.

I began to lift early and late potatoes on the 22d July, and continued to do so for present sale till the 1st September, when the field was all taken up; and during that period we had only 21 days without rain; the crop all perfectly sound and of excellent quality. I may mention here, when I ploughed up the field to be sown with wheat. in December, the potatoes left in the ground at the time of lifting were also found to be perfectly sound and free of disease. From the 1st September to the 17th September, the weather was just what we could wish for all kinds of harvest work; but from the 17th September to the 14th October, I find, from my register of the weather, we had only 8 days without rain—some days a perfect deluge. I began to lift and store my potatoes on the 14th October; the crop was luxuriant, and to all appearance a heavy one, some of which grew upon a light and dry soil, the remainder upon a loamy clay, well drained. The varieties were dons, buffs, and red. The dons and red, if any difference, were the least diseased; this I think might be owing to their being less luxuriant in the stems and leaves. I raised a quantity from the seed in 1844, to all appearance perfectly sound. I planted them again in 1845; but found, when I lifted, they were more diseased than any that I had. My potatoes were all manured with the best stable-yard dung, some of which was spread on in December, the remainder put into the drill at planting. Never having any disease to fear, for 45 years that I have

been in the practice of raising a large quantity of potatoes, I began to store them in the usual way, by putting them into houses, so slight was the disease in appearance. However, in case they might show any symptoms of decaying, I took the precaution to leave room in the house to turn them over, if necessary; and after being 10 days in the house, and finding they were not likely to keep, I set all hands to remove them from the house, and to put them into pits; but before I could accomplish this, so rapid was the decay, that one-half of what I had put into the house I was obliged to drive to the dunghill; and those put into pits went the same way. I had still about 10 acres to lift; all of which I put into pits of from 3 to 4 feet wide, and ventilated them with drain-tiles and straw, and afterwards covered them with straw and a slight covering of earth, leaving the top of the pits open. Out of 22 acres which I had to store, I did not save 20 bolls of sound potatoes fit for man's use. After turning some of the diseased ones repeatedly over, I could only save a very few, which I sold to starch-makers, and for feeding pigs, at 3s. per boll. I am of opinion, after the experience I have had, if there is any mode of preserving diseased potatoes, (of which I have great doubt,) it is to put them into very narrow pits well ventilated, and to cover them with straw or some other light substance.

No. 59.—Mr John Girdwood. Featherhall, Corstorphine, 21st March 1846.

1st, The disease appeared about the beginning of October. I am not aware that there was any peculiarity in the weather immediately preceding its appearance, if we except the general low temperature, for which the latter end of summer, and all the autumn months, were so remarkable. A severe frost in September destroyed the foliage; after which, of course, no change in the stems or leaves could be noticed. I observed, in the early part of the season, a number of white and dried stems in the fields; and patches here and there put on that brown hue which is generally considered indicative of ripeness. The first appearance of disease in the tubers was a blue livid appearance in the neighbourhood of the "eyes," on the "rose" end of the potato; and on removing the skin, a slight brownish-drab spot presented itself, seated in the flesh of the tuber.

2d, The garden potatoes, such as the American early, and some sorts of kidneys, have been least affected. It deserves remark, that those sorts do not bear flowers. I had ten sorts raised three years ago from seed. They were quite as bad as any of the others. I had potatoes on all sorts of soil, from stiff clay to sandy loam; some were manured on the stubble; some in the drill; some with well-rotted dung; others with fresh and "rank" dung; some were dressed (in addition to the dung) with guano, others with a variety of saline mixtures; some with charcoal and salts, others with gypsum; some had their flowers plucked off, others had not. The result was the same in every case, viz. total destruction. I observed, however, that the disease was most obvious at first on the sites of dunghills.

3d, The plan of storing I have found to answer best, is in narrow pits, (the narrower the better,) simply covered with straw. I am afraid, however, this would not be a sufficient protection in cases of severe frost. I found turning and picking injurious; indeed, the less they were handled, the better they kept. Those simply covered with straw kept quite firm to a late period, although nearly all were tainted. They formed useful, indeed I may say highly nutritious, food for cattle, when washed to remove the sand. I do not think sprinkling with lime did any good. Those potatoes which were stored in houses, or "pitted" in the usual way with a covering of earth, began to heat and rot within three days; after which, spreading them thin, or putting them in small pits, had no effect in preventing them becoming a soft and putrid mass.

I intend, should it be necessary in another season, to try pitting in three-feet pits, slightly covered with straw and earth, leaving a complete row of straw-ventilators along the ridge, and having an air-channel, composed of rail, nailed to small triangular frames, running the whole length of the pit, close to the ground, and communicating with the air at the sides of the pit, by means of transversely placed drain-tiles; the mouths of which can be shut in case of severe frost.

I ought to have stated, that I believe all the mischief occurred prior to lifting; that the disease, in fact, had then taken place, although the brown colour was not

so deeply marked, or widely spread, as afterwards it became. I cut a diseased and a sound potato in halves and tied them together, I then placed them in the heart of a pit, but no change took place in the sound one, even after the lapse of months. In these circumstances, what ought to be our main endeavour, is to devise a means of preventing the putrefactive fermentation which speedily takes place in the pits. On this point, the inquiries of the Society may have a most useful result.

No. 60.—Mr JOHN STEVEN. New Mill, Dalkeith, 20th March 1846.

Answer to Query 1st.—Had little or no disease, except from wet.

Query 2d.—Planted the common don—part from sets, and part in whole potatoes; the crop from the whole the best; the soil clay loam, undrained; manured with farm-yard dung only; after wheat stubble; and taken up very wet.

Query 3d.—Stored the potatoes in a large house, about one and a half to two feet deep; turned them over in ten days; took any spoiled ones that appeared; turned them again in about three weeks, and took away the spoiled, and did not lose more than three per cent. Sold them all for eating at 16s per boll. Wherever the potatoes were in pits, the greatest loss was sustained; and when the pits were done up in the usual way, the loss was nearly entire.

No. 61.—Mr F. A. ALLAN. East Pilton, 27th March 1846.

I first discovered the taint amongst my potatoes about the 10th of October. We attributed it, *at that time*, to the very severe rain-blast from the east, (to which my field was particularly exposed,) on Friday the 3d of October. I had not for years so large a crop of potatoes. When the taint came on, the shaws faded very fast.

2d, I had buffs and dons planted, and both were alike affected; but certainly some parts of the fields were worse than other parts. My crop was all manured in the autumn; and I gave them guano, stable manure, and pigeon dung on different parts of the field, but could discover no difference in the one place from the other in regard to the taint. I took the alarm, and put my potatoes in very small pits, and the taint got no worse after I lifted them. Then I picked all the good ones out, and sent them to the market. Three-fourths of the crop were tainted, but they have been of very great use to me all winter in feeding my horses and cattle. The horses have used from 60 to 70 lb. each per day, which saved my oats, and I never had them in better condition. I had a sale of potatoes this year, and some of the purchasers put them up in the usual large pits; and the consequence was, they all rotted. One of the parties who bought at my sale, lost £123 worth by so doing. My servants put some of their potatoes under their cottage beds, where they also rotted. Any of my neighbours who put them into houses or large pits lost the whole of them.

No. 62.—Mr JAMES BERTRAM. Smeaton, Dalkeith, 6th April 1846.

I had sixteen acres planted on clayey soil—the seed from the Pentlands, Peebles-shire, Berwickshire, and the high districts of this county. Three of the kinds were dons, and two buffs. With the exception of a few dormant ones here and there, they came through the ground in a bold and healthy plant, and continued so for a few weeks. Cold and wet weather intervening, they all at once became curled; in fact, spindled up like an ill-grown thistle; and the consequence was, that I had a miserable crop, under 15 bolls per acre. Not anticipating any disease, I stored them as usual, in my out houses, fully six feet deep, and have not had a diseased potato; and to this day they are as sound as when lifted, and of fine quality. The stems withered, or died entirely away in the early part of September; so that the field became exactly like one in plain fallow, and to this, I think, may be attributed the salvation of my crop. I had, likewise, in the same field two acres of "yams," one white, the other red; the latter proved an entire failure, 5 bolls per acre; the former a 40-boll crop; and so luxuriant in the stems, that we found great difficulty in the ploughs operating amongst them at lifting. These, too, notwithstanding the great growth of shaws, are still sound, and which fact rather stultifies what I have said with regard to my general crop.

No. 63.—Mr John Finnie. Swanston, 4th April 1846.

In reference to the first question, I beg leave to state, that as far as I have observed, the disease did not manifest itself either upon my own farm, or any other in this immediate district prior to the 3d day of October. We then experienced a very heavy fall of rain, rather uncommon at that season of the year. The land previously had rather an over-abundant supply of moisture, but it then became greatly overcharged, so much so, that I immediately entertained serious apprehensions for the safety of the potato crop on all retentive soils.

From part of a field where the potatoes were raised ten days previous to the fall of rain referred to, no symptoms of disease were visible, and they were stored at the usual depth, of from seven to eight feet, at the extremity of a barn. The remainder of the field was lifted about the 20th of October, but the disease had then manifested itself. Every precaution was taken not only in removing this latter portion of the crop from the ground in as dry a state as possible, but in storing them in the potato-barn at a depth of not more than three feet, and in disposing of them in front of those previously lifted. Of the potatoes raised after the rain, nearly a fourth part was affected more or less; but on reaching those first stored, they appeared perfectly sound, and no apparent injury was observable from their having being piled up in such bulk.

Another fact, strikingly evincing the effect of the flood in the beginning of October, is this:—My farm-overseer, a man on whose powers of observation I can depend, informs me that the potatoes in his garden, and which he was using daily, were perfectly sound previous to the heavy fall of rain.

The stems after the 3d of October presented an appearance as if a third or fourth had been blighted, and the leaves as if they had been destroyed by frost; but I cannot say that, upon examination, I could detect the disease existing in the tubers formed at the blighted stems to a greater extent than at the others. Even previous to the rain, all the flowers had disappeared. On the evening of the 7th of August, there was a smart frost, which, in my opinion, destroyed the flowers of the potatoes, and to this cause I attribute the circumstance of hardly being able to detect an apple upon the stems in the fall of the past year. By examination of the tubers about the middle of October, I found, on applying the knife to them, and removing part of the skin, that symptoms of decay were observable in nearly a fourth part of them, but the disease had not by this time penetrated, generally speaking, beyond the eighth part of an inch. I can best describe the appearance it then had, by referring to an apple in the first stage of decay.

In replying to query 2d, I shall take the different points in their order. First, then, as regards the question—Whether any of the varieties commonly cultivated have escaped the disease, or been less affected than the others?—The varieties commonly cultivated in this district are the don and the buff, and from my own observation, I would say, that where these have been grown under the same circumstances, and not raised till after the 3d of October, they have suffered alike. I am aware very contradictory statements have been made upon this point. I know myself, that upon some farms the dons are said to have suffered most, and on others, the buffs; but, upon inquiry, I have in general seen cause to believe, that the nature of the land, the exposure of the field, or the strength of the crop, afforded a sufficient explanation of the difference. On my own farm, during the past season, I cultivated both dons and buffs, and each seemed alike. I cannot say what might have been the case with any other variety, but from the examination of the crops of others, where the means of judging was greater, I am induced to believe that the disease has attacked all kinds indiscriminately, and that the differences are to be ascribed to other causes.

2d Point—Whether potatoes recently obtained from seed have been less subject to disease than those which have been long raised from sets or tubers?—I cannot here state my own experience, but I may mention that a gentleman in this neighbourhood, farming his own property, had, last season, a comparative trial made of potatoes raised recently from the apple, others from the small excrescence that is found at the bottom of the stem, and others from seed purchased, but well selected. He had likewise the buffs, blues, and don variety, and the whole were planted in the same field, where the soil was uniform. The disease attacked them

all indiscriminately. The produce of the apple looked better upon a superficial examination, but when boiled or cut through with a knife, the disease was found even deeper seated than ordinary.

3d Point.—Whether any particular condition of the soil, as wetness, previous cultivation, or the kinds of manures used, appear to have had any influence in promoting, retarding, or preventing the disease?—I had a portion of my potato break last year upon naturally dry land, and part where there was an admixture of clay in the soil, but which had been drained every fifteen feet, and subsoiled, and another portion upon a field that had been thoroughly drained, and where the potatoes had never been grown before. On some parts special manures were substituted for part of the ordinary farm-yard manure, but the disease existed throughout. I could not observe that the manures effected any difference, but where the land had a northern exposure, got less of the sun, and did not so readily benefit from drying winds, the crop was injured to a much greater extent than in other parts. I infer that the strength of the stems on the light land promoted the disease by proving a barrier to the necessary drying of the ground; and that the excess of wetness in the clay land, where the stems were not so luxuriant as to have an injurious effect, was the means of aggravating the disease. Before, however, disposing of this query, I may state a fact with regard to planting, without meaning to say that any safe rule of practice can be founded on it.

In the spring of 1844, I made an experiment in order to ascertain whether by planting, when the season was pretty far advanced, any light could be thrown upon the various and contradictory theories advanced in regard to the failure of the potato crop of former seasons, for which purpose, I had a quarter of an acre planted so late as the 20th of June, and, in order to give the experiment a greater degree of interest, I divided the plot into twenty-seven parts, and, to twenty-six of these, I applied special manures without any farm-yard dung whatever; and, to the remaining section, I applied entirely the ordinary farm-yard manure. The produce from each was raised and stored separately, and again planted in the middle of June 1845, on a field most likely, from soil, situation, and otherwise, to be liable to disease. I raised them, however, in the healthiest condition; and upon turning the whole over in the pits some days since, not one unsound potato could be detected. I attach no importance, as regards the escape they made, to the application of the special manures, for those raised from the ordinary farm-yard dung were equally healthy as the others; neither do I consider that the late planting in the preceding year had much, if any, influence in producing the beneficial effect upon the seed used this year, as I had seed foreign to the farm got last spring, and planted upon two acres immediately adjoining; but so it was, that neither in the case of my own seed, nor in that of the seed which I had planted at that advanced period, was an unhealthy potato found, while the part of my crop which was planted of the same seed, at the usual season of the year, was diseased to a great extent.

Upon another part of my farm, I made an experiment for a different purpose. In the spring of 1845, farmers were greatly alarmed by observing much of the seed got from the Highland districts covered with black spots, familiarly termed small-pox, the nature of which will be better understood by referring to the specimen I have sent. This appearance on the tubers annoyed us not a little, as we concluded that such an indication of disease was the certain precursor of what had happened in former seasons, viz., when the seed, apparently retaining its vegetative character, formed in the ground merely small potatoes upon the original sets, and sent forth shoots which had not sufficient vigour to rise to the surface. I therefore felt anxious to ascertain whether our fears in this respect were well founded, and adopted the following experiment. In the middle of June 1845, I planted a piece of ground with such potatoes as had the thickest covering of these black spots, and, adjoining it, an equal extent with such as were free from those appearances. This experiment satisfied me, that the failure in former years had no intimate connexion with the appearance of the black spots; but while it did so, another important fact was evolved, viz., that, without exception, every set planted with the black spots, produced tubers similarly affected, and *vice versa*. In neither case, however, did the disease of last year appear. It further gave evidence of the danger of trusting in seed with any visible defect.

The last query has reference to the modes of storing practiced, &c. As the alarm was general before I commenced raising my potatoes, I naturally turned my attention to what was most likely to preserve so perishable a root. The first precaution I had recourse to, was to have all those on the surface carefully gathered and put by themselves, previous to lifting the general crop, and from this I anticipated a double advantage. In the first place, I could then wait for dry weather, and a dry state of the ground, without risk from frost; and, secondly, had there been frost, which is not uncommon in the month of October, the evil of intermixing in the general store such potatoes as might be injured by it, would be avoided.

The next step was to use slaked lime while the potatoes were emptied by the gatherers into the carts in the field—having a person going from cart to cart, and giving a regular dusting as they were filled—and when emptied at the potato houses or pits, a little more was added.

In former years, it was customary to store potatoes to the depth of from 8 to 9 feet, when in houses, and, if pitted, to the quantity of from 16 to 18 cwt. per lineal yard. In the past season, the depth in houses was restricted to 3 feet, and the quantity in pits to not more than 10 cwt. per lineal yard.

It was likewise usual in previous seasons. to have the pits immediately covered with earth, but this was deviated from, and merely a covering of straw put over them at first, which was taken off daily when the weather was dry and favourable, and replaced at night. As the season advanced, however, the pits were entirely covered with earth, with one or two exceptions, with a drain tile placed every yard along their sides to admit the air. Some of the pits I turned over at the lapse of a month—throwing aside such potatoes as seemed diseased, but as the weather became unsettled, I was compelled to desist from this operation.

Such is a brief account of the method I adopted for the preservation of last year's crop, and which proved, I believed, in some respects, successful. If, however, a similar visitation occurred, I would so far improve upon it, as, in the first place, to avoid putting more together in the pits than 6 cwt. per lineal yard. Secondly, I would have recourse entirely to a covering of straw, put on in such quantity, and with such care, as neither frost nor rain could penetrate to the potatoes; and I have no doubt, well drawn straw, and properly roped down, would effect the purpose. Thirdly, I would dispense entirely with turning over the pits, unless decay is proceeding very rapidly—having reason to believe that those I disturbed were found to be worse than those which were untouched. Fourthly, I would restrict the use of lime where much earth was brought from the field with the potatoes, as it was quite apparent that it encouraged fermentation when employed liberally, but where supplied in moderation, decided advantage resulted.

No. 64.—Mr John Dickson. Saughton Mains, 27th March 1846.

I did not observe any disease in my potatoes of this season, which were a remarkably fine crop, till about the middle of October, just before securing the crop, when the stems and leaves became withered, soon after some very wet weather; the tubers also, on a close inspection, were partially discoloured.

The variety of the potato called the Irish cups, and a small round white potato, which I had from Holland two years ago, were less affected by the disease than any of the other varieties. I found those raised from seed, two years previously, were quite as much affected as those of the same variety, which had been longer cultivated in the usual manner by cuttings.

I did not find that either the previous cultivation of the soil, or the use of different kinds of manures, had any influence in promoting, retarding, or preventing the disease, although I used various kinds of manures. I had one small field planted on the 15th of March with don potatoes, which were all lifted before the 1st of September, and sold in Edinburgh, except about half an acre, which were allowed to remain in the land till about the 10th of November, when that half acre was found to be very much diseased, although, in afterwards ploughing the field, those potatoes which had been accidentally left in the portion of the field where the potatoes were taken up in the month of August, were, without an exception, quite sound and free from disease. The soil in this field was remarkably dry sandy soil.

The mode of storing which succeeded best with me was, laying them on the surface of the ground, in pits of three feet wide, and covering with straw without any earth, and for the first ten days taking off the straw every good day, and allowing them to dry. The use of lime seemed to me to be rather injurious than beneficial.

No. 65.—Mr ALEX. J. MAIN, Overseer to Mr Wardlaw Ramsay of Whitehill. April, 1846.

First Query.—First, "At what period of the season, and after what state of the weather, did the disease manifest itself?" I cannot say that I observed any marked difference in the growth of my potato crop last year, as compared with any previous year. The crop was affected with "curl" from the first, though not of the most marked character; but it continued a reasonable time in growth, and consequently no alarm was excited from premature decay. For this reason, too, I cannot attribute the commencement of the disease to any particular state of the weather. I must explain, however, that my crop was at the date of lifting very partially affected, probably not more than one in one hundred, if so many; hence, in all likelihood, the absence, during growth, of any indication of the presence of the disease. Nor can I learn that, in my neighbourhood, any indication of the disease was apparent, or that it was manifested in any way previous to the crop being lifted.

Second, "What were the general appearances presented by the stems, leaves, and flowers, and by the tubers, when the taint had extended itself to them?" From what I have already said it will be seen that, from the general appearance of the plant during its growth, I had no warning that the taint had, in any way, or to any extent, reached our crop; nor till the potatoes were lifted was I aware of its presence. The diseased tubers, however, were easily observed. The *part* affected presented a dull appearance, and the locality of the disease was chiefly at the *upper end* of the potato. This was not universally the case, but the instances in which I found it preponderate so much, that at the time I supposed that particular part of the potato to be the most obnoxious to the disease. The dull appearance, however, did not affect the *whole* tuber, but merely the *part* tainted, and, to all appearance, the portion of the potato not affected was as sound as a potato in which there was no appearance of the taint. A dark-coloured spot marked the centre of the disease, and when the tuber was cut immediately below the dark spot on the surface, the taint exhibited itself, in appearance resembling a bruised apple. This appearance, in the majority of cases, was found to run along the surface of the potato, immediately below the *dull* portion of the skin. In a few instances, traces of it were observable in the heart of the potato; but the rule seemed to be that the surface was first affected. I am not of opinion, however, that the disease took its rise in the skin of the tuber; no doubt it was first internally affected, and the dull appearance of the skin was a mere sequence to the disease, and of course afforded an indication of its presence.

Second Query—First—"Varieties." I am not aware that any variety of the potato has wholly escaped the disease. Last year I grew the don variety alone, and of course had no means of comparison; but I understand from others that the Irish red variety was, if not entirely exempted, at least not so much affected as the others. And in some instances too, I have been told that buffs were less affected than dons. But in no instance have I heard of complete exemption.

Second—"Potatoes from seed, compared with those from cuts or sets." I have no means of stating my own experience in answer to this, and I am only aware of one instance in which, to any extent, potatoes have been raised from seed. I allude to Mr Main of Dalhousie, who, about five years ago, commenced raising from seed. Last year, of course, his crop of these potatoes was raised from cuts or sets like the others; but he informs me that, though not quite free from the disease, they are much less affected than the crop from sets cut from old tubers. I do not, however, consider this single instance sufficient ground on which to argue a superiority for the new over old grown potatoes. Still it affords encouragement to watchfulness in future; and, probably, by closer attention to raising new varieties from seed, much good might result.

Third—"Particular condition of the soil—as wetness, or previous cultivation."

The peculiarities of the disease, as connected with this part of question second, is somewhat remarkable, and are probably of such a character as to baffle observation. Few soils, wet or dry, light or heavy—this way cultivated, or that way cultivated—can boast of entire exemption, but the degree in which any of them has been attacked is apparently so dependent upon caprice in the attacking element, that on this subject a complete tissue of opinions have been formed, and all resulting in an inextricable mesh. One asserts that wet lands have produced the disease to a larger extent than dry, and another that heavy land has been worse than light; a third asserts *vice versa* of both, and so on. These assertors are in the circumstances of many others, who hazard opinions on difficult questions—all are right, and all are wrong. I will not pretend to cut the Gordian knot. Our experience of the disease is too limited to allow of a sound judgment on this question. There can be no doubt that the disease has been found in every variety of soil, and under every variety of cultivation. The soil on which my potatoes were grown is a light one, with a gravelly subsoil; a neighbour's crop was grown on very heavy soil, with a stiff clay subsoil—the disease appeared in both, but in mine worse than in his. Again, on a heavy soil in the neighbourhood, the disease was exceedingly virulent. These two last mentioned heavy soils were dry or drained, but in a third *undrained* heavy soil, and very wet, the disease was greatly more moderate than in the last mentioned heavy soil. Again, my soil had lain a considerable time in grass, and a considerable time had intervened in cropping it with potatoes—it was moderately affected—the first named heavy soil had been frequently cropped with potatoes, and at much less intervals of time, and the disease was but very slightly apparent, much less so than in mine. These are peculiarities in the character of this disease not easily accounted for, and certainly afford nothing to lighten the difficulty of theorizing on the different kinds of land most subject to its ravages. Most farmers, however, with whom I have conversed on the subject, agree that the disease was most powerful in wet and *confined* situations. I am disposed to agree in this, but deductions from other facts would incline me to attribute the prevalence of the disease in such situations to their *confined*, rather than their wet, character. Want of proper air—want of a free healthy circulation, may have much promoted the disease; and I am not sure if a sounder theory for its existence may not be based upon this circumstance than is sought to be adduced from the peculiar character of soils, or the peculiar mode of their cultivation.

Fourth—"Kinds of manures." I suspect my answer to this must bear much the same complexion as the last. I had my potatoes planted last year with a great variety of manures, and in all the disease appeared. I may state, however, that the existence of the disease itself took all with such surprise that little attention was given to this subject. I did pay a slight attention to it, but found the disease so equally distributed, that my curiosity was not sufficiently excited, consequently I drew no definite conclusion. What degree of conclusion I did form was unfavourable to the idea that manures had any influence in promoting, retarding, or preventing the disease. I do not offer this as an opinion, but a mere impression formed on very slight premises, and one which correct observation may alter.

Third Query.—"What have been the modes employed of storing the potatoes, and what are the means which have been found most successful in preserving healthy tubers, and preventing the extension of the taint from the diseased to the sound ones." In my own case, I adopted the modes of putting the potatoes in very narrow pits—dusting them, as they were being stored, with a compost of lime and sand, and using means to allow the moisture generated by their confinement in the pits to evaporate. This last end I sought to obtain, first by leaving the pits uncovered at the top with soil for two or three weeks, and by the introduction of numerous "lums," or flues of straw, extending *all the depth of the pits.* I turned the potatoes *once* previous to the spring, when they were again turned for the purpose of being picked. Of course, in the process of both turnings, the diseased tubers were removed, but I did not get out of probably 50 or 60 bolls more than 3 bolls of diseased potatoes from both turnings. I had also about 30 bolls stored in a house, and they also were dusted with lime and sand compost. These did not keep as well as the potatoes stored in the pits. I had to turn them oftener, and I always got a greater number of diseased tubers; probably out of the

30 bolls I would have from 4 to 5 bolls, and these in a much worse state of decay than the others. I am not positive as to the success of the means I adopted to preserve the potatoes, though I am inclined to attribute some little merit to them. The great object aimed at was to *dry* the potatoes, and no doubt this object was to a great extent gained. At the turning during winter, the potatoes had a dry appearance, and the diseased ones were found, not in masses, but scattered in many instances in single potatoes throughout the pit. Probably, had these not been removed, they would have tainted others; but I inferred from the fact, that the state of dryness to which the pits had obtained, had a favourable effect in preventing the spread of the disease. Hence I argued favourably for *dusting* the potatoes when pitted. The compost consisted of the proportion of one cart of lime of 2½ bolls, to 3 carts of sand.

A neighbour of mine, among whose potatoes, when lifted, the disease was by no means so prevalent as among mine, did not adopt this precaution. He kept all his potatoes in houses, turning them often during winter. His method of allowing the moisture to evaporate was the same as mine—by means of straw flues, placed every three or four feet, and reaching all the depth of the potato heaps. He had very few diseased potatoes among his crop; probably out of 100 bolls, not 2 bolls affected, and these so partially, that for the most part they were used for his horses. In this case, while I would make due allowance for the care exercised in turning the potatoes, and much for the means used to allow the moisture to escape, I am of opinion that the absence of the "taint," to any serious extent, is to be accounted for as much to the fact, that the attack was of a *mild* character, as from any good resulting from the care bestowed on the keeping of the crop.

In other places, again, the potatoes intended for seed, were kept in the ground during winter in alternate drills furrowed up. In the spring, these potatoes were lifted quite sound, or rather the taint had so slightly affected them, that it almost amounted to an exemption. The portion of the crop lifted, however, was nearly as little affected. and, therefore, no very conclusive comparison can be made in reference to this mode of keeping. There cannot be a doubt, however, that the less the potatoes are brought together in masses, the less is the probability of the taint spreading; the *drier* and *cooler* modes of preservation having a most decided advantage over every other. In any year this is true, and farmers would consult their interests more than they do, if this were attended to. The practice of keeping large masses of potatoes together, without adopting measures for keeping them *dry* and *cool*, is most pernicious; and perhaps to this cause, as much as to any other, is to be attributed the prevalence of the various diseases which of late years have attacked the potato crop.

Should the disease unfortunately reappear in the potato-crop of this year, much more care and attention can be bestowed on it, and its character more closely investigated. Of course it remains to be seen whether a diseased tuber will produce a diseased crop; some doubt that it will, and I confess I am one of them. My reasons I need not detail—the result of experiment alone can determine the question, and no doubt it will be fairly tested. Of the cause of the disease itself I believe we must regard it as a mystery. I am not of those who think they can find the solution of the question in the wetness of the last season, or in a deterioration of the plant itself. My opinion is, that it is epidemic in its character, and is to be ranked with cholera among men, and murrain among cattle. No doubt the state of the atmosphere may, to a certain extent, be chargeable with its presence, but only as the *agent* of its transmission to us, not as containing, *inherent in itself*, the *germ of its existence*. As little faith have I in a deterioration of the plant itself. In many cases, the strongest and healthiest shaw was the most affected by the taint, while, as in my own case, the crop evincing the largest amount of decayed vigour, nearly escaped. The fact seems to be, that no natural law with which we are acquainted, is in any way chargeable with the control of this destructive visitant. The chief lineament of its character was independence of action; and that action was of the most erratic description. Hence, in my opinion, its strong resemblance to cholera and murrain. If it seized this neighbourhood it passed over that, only however to attack another,—here it attacks a crop on light land, and nearly exempts one on heavy land, and *vice versa*,—there it seizes an inferior crop, and spares a good one,—while again, a most luxuriant crop is destroyed, and a bad one exempted. Why this versatility of character?

I can account for it in no other way than on the supposition that the disease is epidemic. This conclusion may be the result of fancy—future experience will determine it—but I think I can perceive the family likeness so strong, that I cannot resist the conviction.

All that can now be done, is to watch carefully the progress of this year's crop, noting the results of our watchfulness, and adopting such means for securing healthy plants as past experience has found beneficial. Of course these are chiefly to be found in healthy seed, good manure, and a careful preparation of the tubers to be planted.

FIFESHIRE.

No. 66.—Mr P. Hume. Fordel, 13th March 1846.

1st, The disease was first observed on the 25th August in the tubers that had been earliest planted, (and those were by far the most affected;) and about two weeks after on those which were planted later in the spring. The disease appeared after a long tract of sunless, cold, and wet weather, the leaves becoming black-spotted, and the stems having the appearance of being nearly ripe, and of being healthy until the seed apple was considerably enlarged. The disease on the tubers was most instantaneous, and every day more and more apparent.

2d, None of the varieties planted here have entirely escaped the disease. A light red sort, imported from America five years ago, was less affected than those commonly in use, and the Mangelwurzel variety was still less so than it. Little or no difference was observable from the nature of the soil, in three fields which, although of different qualities, exhibited the disease in much the same degree. Those planted latest, about the 15th of May, were by far the least effected. With well prepared farm-yard manure, and among a variety of cottagers, no difference could be observed, in any degree, in the disease.

3d, We have found that whenever the potatoes were pitted in the usual way, by being closely covered with straw and earth, a total failure has taken place, and when dried by artificial heat equally so; where put into narrow pits, and only covered with straw, they were much better preserved, but we found they kept best in-doors, lying about two feet thick, and regularly turned over once a month or five weeks, and all the diseased ones picked out.

The above is a plain statement of what has come under my own observation, as requested by the Highland and Agricultural Society. Allow me further to state, that I recollect well of 1816 and 1817, when we had cold sunless summers, and yet had very good crops of potatoes, although in one of these years the crop was nearly lost by a premature frost. That the vegetative power of the potato has been failing by degrees for the last 15 years, has been most apparent to every one here, and it is believed that the *extrem ly* sunless, wet, and cold summer of last season has greatly accelerated that tendency.

No. 67.—Mr David Don. Keinbeath, 14th March 1846.

I had about 10 acres planted last year; at lifting time in October there were about one-third of the crop diseased, but where the ground was a little inclined to moss, it was freer of disease than on the other parts of the field which was a loam on a clay subsoil. I lifted every alternate drill, and covered the remainder with a strong furrow from each side of the drill, where they are keeping very well, and I am inclined to think that those of them which are perfectly sound will be as safe to plant as any I can purchase. My loss was chiefly in buffs with a small part of reds, but none of them were free of disease.

1st, I may state, that in this district there was a strong hoar-frost in the early part of September, which blackened the shaws very much, and which I have no doubt injured the crop, although I did not observe the disease in the potato till some time after.

2d, The Irish cup potato has been less diseased in this quarter than others. The greater part of my potatoes were manured with farm-yard dung, but a small part with house ashes, and both were alike diseased.

3d, My mode of storing the potatoes was putting them in small pits with a good thickness of straw for covering, (but no earth,) and picking and turning them over two or three times, by which means I have lost comparatively few. I observe that those in this district who covered them with earth, have in many cases lost the whole crop.

I may mention that in 1842 I had a part of my potato crop, about three or four acres, that seemed to be affected with the same disease, and which I attributed to late planting, or rather cold land. I planted about the middle of May, and lifted about the end of October, when the potatoes looked quite well, but became diseased in the pits, and this has deterred me from covering potato pits with earth ever since.

No. 68.—Mr James Kerr. Middlebank, Dumfermline, 18th March 1846.

1st, My potatoes were planted about the 20th April on thoroughly drained land, the soil deep loam, well adapted for potatoes, and in good condition; the kinds planted were red, buff, and droppers. I was not pleased with the seed of either sort, as all had evident appearance of disease. There were many blanks in the field, but the plants that came up were vigorous, and continued healthy till about the middle of August, when the shaws began suddenly to fail, as if the potatoes had been fully ripe, at which time I began to lift a few, and then no appearance of disease could be seen, but in ten days strong indications of some thing unusual was apparent, and increased till the whole were lifted, about the end of October. At that time I considered that fully one-third of the crop were affected; however, the actual loss has not been above 5 per cent. What were not fit for food for man I used in feeding cattle.

2d, About the middle of August, when I began to try the potatoes, the reds appeared to be less affected than the other varieties, but they gradually became as bad as the other kinds. I have not been able to discover any thing particular in the state of the land, manure, or previous cultivation, which could have had any influence in promoting or retarding the disease.

3d, The usual mode of storing potatoes, has been in close houses and pits. In both cases large masses were put together, those in houses generally covered with straw, in pits with straw and a heavy covering of earth—whereby air and ventilation were completely excluded. The bad effects of both these modes of storing have been felt for years; very frequently the seed did not vegetate regularly, failures often occurred, and many plants that did come up, were weak and sickly, and did not produce a crop worth cultivating. Those failures I have attributed in a great measure to the potatoes being heated in the stores, whereby their germinating power was either destroyed or materially weakened. This year I stored part of my potatoes in an open barn, thinly spread on the floor, without any covering, and they kept pretty well, but not nearly so well as those in narrow pits, with no cover but straw. In neither case could I discover that the disease had been communicated to those previously sound. I did not turn any of my potatoes, nor did I use any means for absorbing the moisture; indeed, these expedients were not required, as the potatoes were taken up in fine weather, and were quite dry.

I may add that I havė a strong impression, that this disease in potatoes has existed, and been known in different parts of the country for years.

No. 69.—Messrs William Young & Co. Grange Distillery, Burntisland, March 20, 1846.

1st, The disease first made its appearance from the 14th to 26th September, by the shaws or stalks and leaves becoming suddenly and prematurely blighted, and shortly afterwards the potatoes began to show disease, by having brown

spots on the tubers, which gradually enlarged until they were a mass of decayed matter—particularly after being pitted.

2d, The variety called buffs was most affected, the reds were less so, the white yam kind less than either, and the early kinds almost free of disease. We had most of the disease where the land was richest and in the highest state of cultivation.

3d, We pitted most of our potatoes. Those that were slightly covered and frequently turned over and exposed to the air, kept better than those well covered and excluded from the air. We think hot lime acted beneficially by absorbing the moisture.

No. 70.—Colonel J. F. Briggs of Strathairly. Largo, 21st March 1846.

In the first place, the partial failures of the potato crop for some years past have not been uncommon, and have manifested themselves by the seed rotting in the ground, in consequence, it is supposed, of the dry and hot weather during which it was committed to the soil, and from incautious planting after the manure had lain for some time exposed to the action of the sun and air, previously to closing the drills. In most cases, when the seed was planted on well decomposed manure, in newly opened drills, which were immediately closed so as to retain the moisture, the plants grew vigorously, and arrived at full maturity.

The precise period at which the disease, which so secretly and so generally destroyed the potato crops, commenced in this vicinity, I cannot now remember; but one thing is certain, that indications were apparent some time before the commencement of harvest, and immediately after a heavy gale of wind and fall of rain, succeeded by sultry weather; at which time, the leaves assumed a brown, rusty appearance on the lower side, and the stems began to "go off" gradually, but prematurely. Shortly after, it was rumoured that all was not right with the crop; on inspection I found mine affected in a small degree, but slightly when compared with some of the fields in the neighbourhood. The variety the least affected by the disease was the American early, which has kept, up to the present time, with very little loss; the blue dons and buffs having been about equally affected, these being the only varieties I cultivate, with the exception of the very early garden kinds, which had no appearance of disease about them when used—these are, the ash leaf, Taylor's forty-fold, and one or two other kinds (names unknown to me.)

I have not been in the habit of raising potatoes from seed, therefore can give no information on that point.

On imperfectly drained strong loams, the disease has been the most active and destructive in its ravages; on dry light soils, it has here made little or no appearance.

As I use almost exclusively cattle-yard manure, I cannot say what sorts may be the best to prevent disease, or, more properly speaking, the least likely to encourage it; but this I know, that where guano was used by way of experiment, in rather a dampish soil, the potatoes were almost entirely destroyed.

The potatoes on my farms were stored in pits as usual, but more than ordinary care was taken to establish a thorough ventilation, by means of chimneys formed with drain tiles along the top of the pits, at the distance of three yards from each other, common tiles being placed over the tops of the chimneys to prevent rain getting in; and, by cutting holes in the sides of the pit, near the bottom, a foot square, and at the distance of two yards from each other, by means of which a thorough draught of air was maintained throughout the pit. By observing such precautions, it is our opinion that such of the tubers as were pitted in a healthy state have suffered no deterioration since. In conclusion, taking into account what have been consumed by the feeding of cattle, I do not believe I have lost in all above 3 or 4 bolls out of 160 or 180 originally pitted. I have still about two acres of potatoes not lifted; and so far as I have ascertained, these are still safe. It is consistent with my knowledge, (though derived from information received from a small tenant-farmer in the neighbourhood,) that when blue

dons and white dons were planted in the same field, the soil being pretty equal throughout—planted in the same day, with the same quality of manure, and similar cultivation—the blue dons almost all failed, while the white dons were entirely free from disease.

No. 71.—Mr Robert Russell, Secretary to the Trafalgar Agricultural Society. Kilwhiss, by Auchtermuchty, 25th March 1846.

The disease, in this district, was little thought of, until about the middle of October, when the farmers had begun to store. The weather during the first part of that month was very wet and cloudy, and very little of the crop was harvested until the 20th, when the weather cleared up. So far as I am aware, the effects of the disease were never noticed on the leaves and stems, probably because it was altogether unexpected and unsought for, and more especially as the temperature was near the freezing point for some nights in September, which naturally affected the leaves, and gave them a diseased appearance. At the time of storing, the disease manifested itself in the tubers by the rusty gangrene, very general on all lands where the potatoes were a full crop, and always was worse where they had been stimulated by a greater quantity of manure. The more *mealy* the condition of the tuber, the more seriously were they affected. The disease is now very general where it was hardly observed at the time the potatoes were stored. Storing in narrow pits, lightly covered, and in dry condition, seem to have retarded, to a certain extent, the progress of the disease; while those which were put in larger quantities, and in a wet state, underwent the putrefactive process much more rapidly. The only variety of potato which has been little affected is that which goes under the provincial name of "catholics," (a coarse lumpy potato,) and some of the common early potatoes which were planted in the gardens, and *stored early in the season;* the buff, blue, and red varieties being all bad. At certain higher elevations, the potatoes seem to have escaped; we could not, however, define the limits. Certain natural depressions in the district have also escaped, we think from a special cause, which has been erroneously assigned as the one for the general prevalence of the peculiar malady, viz. a low temperature. There are some farms in Stratheden, from their basin-shaped surface and wet mossy subsoil, that are very subject to hoar-frost early in the season. Part of my own farm is in this condition, and it is a striking fact, that all the potatoes in the immediate locality which had the leaves struck down by hoar-frost on the 13th September, are at this moment sound and free from taint. I may mention the particulars in my own case, in corroboration of the above. I planted 14 acres of potatoes on part of a field where the soil was a mossy loam—the varieties were blue, red, buff, catholics, and American early. By the 1st September they had the appearance of being a full crop, but on the 13th September there was a sharp hoar-frost in the morning, and in consequence of which the leaves were all blackened, and in in a day or two they were rustling with the wind. The blue and buff varieties were a good crop, and nearly matured; the other varieties were not at all ripened. Up to the present time I have been unable to detect any symptoms of the rot in any one of the varieties, although they were severely treated by being flooded with water during the storm of rain on the 3d and 4th October. They were dry-stored in narrow pits about the 20th October, and are still in fine condition. Another part of the same field, a little more elevated, which was likewise in potatoes, and similarly treated to the other part of the field, gave a good exemplification of the influence of certain circumstances on the fate of the crop. The soil was a sandy loam, and dry to a fault; the foliage was unaffected with the hoar-frost of 13th September, with the exception of a few spots, and suffered more on the 20th and 24th of the month, when we had still a lower temperature through the night. The rusty appearance was observed amongst the blue, red, and buff varieties by November, but not to any extent; the catholics being free, and are so still. The only potatoes on this part of the field which were much affected were a few which had been set aside when planted,

for seed, of the buff variety, and they were of the same stock as those planted on the mossy ground. The only cause which could be assigned for the condition of this portion was the circumstance of their being planted under the shade of a large beech tree, which had prevented free radiation, and the consequent lowering of the temperature to that degree so as to affect the haulm of the stems, and they were the only green stems in the field when the whole were taken up.

From the above facts, and some others which have been related to me, I am of opinion that it is highly probable the potatoes in Scotland would have in a great measure escaped the dreadful calamity last season had they been stored a month or six weeks sooner than they were. I trust that the above facts which I have furnished to you will not be unserviceable in your investigations into this obscure phenomenon in vegetable physiology.

No. 72.—Sir Ralph Anstruther, Bart. of Balcaskie. April 1, 1846.

The disease has been very prevalent in this neighbourhood, attacking all the various kinds of potatoes usually grown on a farm: A remarkable exception however, was observed in the species called here the American early. One of my own tenants raised a large quantity, not one of which exhibited the least symptom of disease; and having learnt from other quarters that the same thing had been observed, I naturally became anxious to try them as seed, and, as a *great favour*, obtained one boll for this purpose.

They were put into the ground on the 19th March, partly cut and partly whole, the cut being dried with a little lime, and all being to every appearance perfectly sound.

They were examined a few days ago, when it was found that the cut sets were all to a greater or less extent in a state of decay exhibiting the usual symptoms of the disease, while the whole sets were quite sound and germinating. The tenant from whom they were obtained had only planted a few in his garden, which, on being examined, showed exactly the same result.

In the same field I had planted a few buffs, all uncut, being selected from a crop grown by myself when the disease had partially shown itself, and which are, as yet, perfectly sound, and growing.

On making these facts known in the neighbourhood, other parties who had put in their seed, have had it examined, and the result has been the same, the cut sets much diseased and the whole perfectly sound.

I think it of considerable importance that these facts, with the obvious inference in favour of planting whole potatoes, should be made public with as little delay as possible. In reference to the printed circular from the Society, I would remark, in answer to the 2d *query*, that of my potato crop of last year, which consisted of blue and white dons and buffs, the latter have been by far the least affected by the disease, and that generally I have remarked that the potatoes of all kinds which have remained sound, have been far better than the average of the crop of former years, as if it were only the very best that were able to struggle successively against the disease.

With regard to storing, I have tried three different plans—a certain quantity I placed in a dry airy loft, spreading them about nine inches thick, others I put into a potato-house, in a mass of three or four feet thick, and the remainder in long narrow pits, ventilated by means of common draining tiles running longitudinally, with air vents every few feet. I found the last mentioned keep the best, those in the house next best, and those in the loft the worst, while I expected totally different results.

HADDINGTONSHIRE.

No Mr James Bruce. Waughton, Prestonkirk, March 17, 1846.

1st, At what period of the season did the disease manifest itself? Ans.—about the middle of September.

2d, And after what state of the weather? Ans.—After much rain, accompanied by a very low temperature. Thermometer rarely above 55° Fah.

3d, What were the general appearances presented by the stems, leaves, &c.? Ans.—As if they had been subjected to the influence of severe frost.

4th, Whether any of the varieties have escaped, or been less affected than the others? Ans.—None have escaped, though the Irish cups have suffered in a much less degree than any of the others.

5th, Whether potatoes recently obtained from seeds &c.? Ans.—None so propagated.

6th, Whether any particular condition of the soil, as wetness, previous cultivation, or the kinds of manure used, appear to have had any influence in promoting, retarding, or preventing the disease? Ans.—They were planted both on wet, and naturally dry soil, but suffered equally, with the exception of a small spot very mossy, which escaped comparatively free. No kind of manures seemed to have any effect. About five acres of them had been planted after tares, which had been top-dressed with one cwt. of nitrate of soda to the acre, in spring 1844; the same land was dunged in the autumn, and planted with potatoes in 1845, and was again top-dressed with one cwt. of sulphate of magnesia and one cwt. of sulphate of soda to the acre, but the effects were equally bad with those that had received no saline preparation.

7th, What have been the modes employed in storing, &c.? Ans.—Different methods have been tried, but the most successful is to lay them up in long narrow pits, running north and south, freely exposed to the west winds—and covered with straw alone, and no more of that than simply to preserve them from the effects of frost and rain—the great matter seeming to be to get them dry, and keep them so.

No. 74.—Mr Andrew Howden. Lawhead, May 1846.

First Query—Upon a field of fourteen acres of potatoes, the disease manifested itself about the first of October, soon after we had experienced a severe storm of wind and rain for two days, and frost, with ice, on the third morning. The stems and leaves of the potatoes suddenly withered; and in the tubers, under the skin, black spots, indicative of corruption, were now seen.

Second Query.—In answer to this, the Connaught cups were but little affected. A great part of the produce I have sold, and at this time find them good for the table. Every other variety was much diseased, notwithstanding which, they have been made available in fattening cattle along with turnips. The soil of the field which produced the crop is very dry and loamy. The manure, farm-yard dung, twelve double-horse cart-loads per acre ploughed in after harvest, and the like quantity put in the drills when the sets were planted.

Third Query.—The mode which I employed in storing the potatoes, was, putting them in narrow pits, to which they were carried from the field in bushel bags, and a quantity of calcined earth riddled upon every bushel as it was emptied into the pit, with a view to prevent the extension of the disease. The pits were thatched neatly with straw, upon which, after a fortnight, upon one of the pits, (luckily the largest,) a thin covering of earth was placed, and upon the other, a thick coating of earth—both being ventilated. It turned out that the potatoes upon which a thick coat of earth was placed, were nearly lost; whereas, those lightly covered continued to be useful as food for cattle. Several of my neighbours did not lift their potatoes, but covered them in the drills with the plough, and recently, upon lifting them, find that the disease has not increased, but that half the crop is still sound.

In conclusion, I apprehend that much may be gained by raising more varieties from seed—selecting the best. And I humbly suggest that great attention should be paid to the condition of the land, when potatoes cut in the ordinary way are put into it; as when the land is very dry, it extracts from the set that sap which gives life to the young plant, and which in very wet soil becomes inert—causing the seed to perish. A few years ago, seed potatoes from the hills were considered to be more productive if planted a second year, but recently, in many instances, they

have failed the second year. Acting upon the system of cutting in autumn the potatoes which are intended for seed, I learn that some of our most correct experimenters have had no success in it.

I resolve hereafter to go to a late climate for my seed potatoes, select what are little sprouted, cut them, and keep them in small heaps for a month before planting.

INVERNESS-SHIRE.

No. 75.—Mr Alex. Mackinnon, Factor to Lord Macdonald. Corry, Skye.

In the month of March, after much wet, though mild weather, the tubers appeared perfectly sound at the time of raising them, and no disease was suspected until the pits were opened. No variety has escaped. I have never used sets raised from seed.

Every potato grown on my farm has been lost, except those cultivated with sea-weed in lazy beds, which have entirely escaped. I have discovered none, though I have stored them both in-doors and outside—the latter in thatched pits, as well as in ones merely covered with earth.

No. 76.—Mr Alex. Simpson of Teawig. Beauly, 17th April 1846.

I have to state, that having entered my farm only at Whitsunday last, I can give no practical information in regard to *culture*.

In regard to *preservation*, I would notice a plan which I adopted for the storing of those purchased by me for the year's consumption.

Having put them into pits of the ordinary size, I placed a layer of brushwood (pruning of hedges and young trees), of 4 to 6 inches thick, immediately upon the potatoes. Over this, I laid the usual covering of straw, and completed by a thick coat of earth, with ventilating holes kept open by plugs of straw. There was thus a comparatively free access of air to every part of the surface of the potato heap.

They were stored in rather a damp state on the 30th October, and not opened nor examined until the 7th of March, when they were found in excellent condition, quite sound and fresh, and very little sprouted. My servants had stored their winter stock of precisely similar quality, without the brushwood between the potatoes and the straw, and, on opening their pits, the difference in their condition, compared with mine, was very striking. Theirs were much moulded and very soft, though not actually diseased nor decayed. Had a tendency to disease existed, I could have no doubt that the difference in the mode of storing would have much accelerated the destruction of my servants' stock.

The above appears such a very simple measure of precaution, that I should not have ventured to bring it under the notice of the Society, were it not for its complete success in my small (but very fair) trial, and for my observing no record of such a plan having been adopted, or any suggestion for its adoption.

KINCARDINESHIRE.

No. 77.—Captain Robert Barclay Allardyce of Ury. 14th March 1846.

Happily, this county, Kincardine, has been almost entirely exempt from such a calamity, and in this immediate neighbourhood the potatoes were even of finer quality. I have made particular inquiry amongst the farmers of this county, and find there is nothing to complain of; and such, I understand to be the case with all the northern counties. When the pits are opened at this season of the year, a proportion of rotten potatoes always have been, and always will be found. Nothing, therefore, connected with the disease has come under my observation. As regards myself personally, I plant only a limited quantity of potatoes, all of which are excellent.

No. 78.—Mr ROBERT WALKER. Portleithen Mains, 25th March 1846.

1st, I did not observe any appearance in the stems or leaves until a week before they were dug, when I observed the stems to fall very rapidly, and get ripe all at once. Not knowing the cause, I thought nothing of it until I began to take them up, which was on the 24th of October, when I found that the whole were affected with disease, except two bolls planting, of which I purchased the seed from mossy ground.

2d, The long blues were most affected before lifting, and have kept worst during winter; but the seed purchased from mossy ground was not in the least affected, and have kept perfectly sound up to this date. Those spoiled were planted with my own seed, which I had used for four years without changing; theywere all of the long and round blues; the land was very dry, and in the best possible order; the manure was a mixture of horse dung and short dung from towns, put up in a hill, and properly mixed two months before being put into the drills. The potatoes were planted on the 23d of April, and were a heavy crop, and of good quality; some later ones, and of bad quality, were not affected; the average of rotten ones, when taken up, was about one-fourth; the soil was a brown light loam, dry and early.

I never had a failure of potatoes before; but I must state that my practice in dunging them previous to last year was quite different. I always put the dung on the land in the month of December previous to planting, and whether or not that would make any difference I cannot pretend to say; but this I know, for the last twenty years I have had no failure nor spoiled potatoes in the ground, nor in the pits.

3d, After taking up all my potatoes from the ground, and dividing the good from the spoiled, I put them in pits as usual, 5 feet broad, and from 12 to 20 feet long, covered with turf and a little earth, with straw flues in the top, and in the middle of December I opened the whole of them, and found the disease going on very rapidly, except in the produce of the seed I had purchased from mossy ground. I pitted those again, which were not spoiled, for the winter, with straw flues on the top of the pits at 4 feet apart. The spoiled pits I picked all over, and put the best into one pit, the second best into another, and the spoiled were given to the pigs. At the same time, I applied slaked lime mixed with a little earth, at the rate of three shovelfuls of lime to one of earth, properly mixed and riddled, on each layer of potatoes put in the pit; and at the rate of 20 bolls of potatoes and 1 boll of lime-shells in another pit of the same potatoes. I put a quantity of salt on each layer of potatoes, covered them both with turf as before, sufficient to prevent frost, with straw flues. I put one pit beside them of the best sort, those with the salt and lime being more unsound. On the 22d of March I had the whole of my pits opened, and found them in the state under mentioned:—

1st, Those from bought seed, and which got nothing to preserve them, were in the best possible condition.

2d, Those with lime were equally sound and much sprouted, about an inch and a half growth being upon each potato, and although a little diseased when pitted, appear now perfectly healthy. I had some of them cooked, and found them fully as good in flavour and dryness as they were before they were limed.

3d, The salted were nearly all gone, except a few below the straw flue, which appeared quite sound, with the exception of a few rotten ones mixed through the heap.

4th, The pit that had nothing done to it but picking, and which was the least diseased, was all rotten except one out of fifty. I may remark, that the pits were placed with the ends east and west; those on the north side of the pits were in general much less damaged than those on the south.

It appears perfectly clear, in my case, that lime is a sure preventive or cure for slightly diseased potatoes, and I am also quite certain that a change of seed from a different soil, or I might say more particularly, from moss to loamy or clay soils, would be of advantage. I have never seen this disease in potatoes before, although I have often seen failures here and there every year, which appeared to be from bad seed, or from the dung in the land being too dry when planted; but in

the case of my potatoes *last* year, they brairded very early, and grew most luxuriantly; in fact, the crop was admired by every one who saw it. The failure in this part of the country does not appear to be to great extent, but is to be found here and there all over the county.

No. 79.—Lord Arbuthnot. Canterland, March 1846.

The disease which so extensively affected the potato crop of last year, probably appears among the potatoes more or less every year; and the cause of damaged potatoes has been hitherto attributed to frost, or to their having become heated after being stored, from an excess of moisture.

The appearance of the crop here, and in this district, while growing, as well as when being taken up last year, would not have led to any particular observation, had it not been that the reported extensive failure of the crop to the southward attracted attention; but on examination it was found, when they were in the course of being taken up, that a few of them had the coloured blotches and the indications of the disease as described, where it had made a serious impression; only here the diseased potatoes were very few, and were considered by the people working among them as not in a greater proportion than might have been seen in most years without occasioning any particular remark, except that there were a few spoiled or frosted potatoes; and in storing the crop it was not thought necessary to pick the bad ones from the stock till they should be required to be screened for market, or taken up for home use.

Potatoes are generally stored in this neighbourhood by depositing them in longitudinal heaps, called pits, along a ridge of a field, and covering them with some straw upon which a good deal of earth is thrown up, and beat down to defend the potatoes from frost and rain; and from what has happened here in the two last seasons there would appear to be an evident advantage in covering the potatoes slightly, at any rate at first when taken up and deposited in the pits; and perhaps they ought to be less loaded with earth than they generally are, which may be inferred from the following circumstances:—

The potatoes here, crop 1844, were taken up, one half before the other, at an interval of about a fortnight. Those first taken up were allowed to remain with a slight covering of straw and earth till the other half were taken up, when the whole were completely covered with earth in the usual manner, and small openings were made in the top of the pits, filled with straw wisps, to allow any heated air to escape which might be generated among the potatoes. In the course of next spring the pits were observed to be sinking in some places, and when the potatoes at those places were examined it was found they were in a putrid state, but except these particular clusters the potatoes were well kept, and the damage was supposed to have possibly arisen from rain getting into the pits by the apertures in the top, from which the straw plugs had not been early removed. It was noticed, however, that the potatoes were less affected in this way which had been first taken up, and had been allowed to remain a fortnight with only a slight covering over them.

Again the potatoes of crop 1845 were all taken up at the same time, but they were stored in two divisions. One of them was intended to be sold early, and, on that account, got a lighter covering than ordinary, and no eligible market having offered for them till February, it was then seen that there were a few rotten potatoes among them, nearly corresponding to what had been seen to have the incipient marks of the disease at the time they were stored in the pits in autumn, but the disease did not appear to have spread.

The other division of the same crop was fully covered with earth in the ordinary way, and without ventilating apertures in the top of the pit. About the same time in February, some portions of this pit were noticed sinking, or falling in, and on opening up the pit at these places the potatoes were again found in a rotten state, as in the former year, but to a less extent, the portions destroyed not exceeding a peck or two at one place. There could be no doubt of these small masses being affected with the disease in its various stages.

The potatoes are of the species called buffs, and in both years yielded about an average crop.

No. 80.—Mr ALEX. MACKIE, Gardener to LORD ARBUTHNOT. 30th March 1846.

The only case of diseased potatoes, of crop 1845, that has occurred in this and the adjoining parishes, happened at Townhead of Arbuthnot. Having inquired into the circumstances, and examined the present state of these potatoes, I find that—

1st, The *white kidney* potato, grown on good dry land from *tubers*, produced about 8 *bolls*, of which about *one-fourth* are rotten. They were taken up as wanted before the regular time of lifting; had black spots on the surface, and when cut were found to be of a brownish colour, spreading through the potato. The stems did not shew the least appearance of disease during their growth; and no cause can be assigned for the disease.

2d, On the *same field*, a much larger quantity of potatoes were grown from sets of the kind called *London dons*; there are now very few of them rotten, and certainly not to a greater extent than in former years. These were pitted in the usual manner.

3d, Here, where a large quantity is grown, both for the use of the family and for other purposes, we had an excellent crop, both in quantity and quality; part were pitted, and part stored in dry houses; but in this district the general practice is to pit the potatoes, and when proper care and attention are bestowed, it is difficult to say which mode is preferable.

I do not believe the disease is a new one, as I have seen it, in some kinds, but to a very limited degree, for several years. I have raised potatoes from the seed, though not generally practised here, but cannot yet state the result till a further trial—hitherto it appears successful.

No. 81.—Mr JOHN STEWART. Mains of Catterline, 24th March 1846.

In this district of Kincardineshire every farmer has an abundant crop of potatoes, and they are of excellent quality; and at this date they are all sound and free of disease; in fact, I do not know of a single tenant having unsound or diseased potatoes in this county.

No. 82.—Mr JAMES FALCONER. Balnakettle, 27th March 1846.

1st, Unless in cold wet soils I have heard of no instances in this district where the potatoes were observed to be diseased, until they were taken up in October, and but very few till after they were some time in the pit. The leaves and stems generally retained a fresh healthy colour throughout the season, though deficient of flowers. After having been two or three weeks pitted, the disease, in not a few cases, though not generally, began to appear by the eyes of the tubers becoming mouldy, and when cut with a knife, showing brown spots diverging from the surface, similar to a fracture in an apple which happens to drop from the tree. When boiled they become hard, and emit an offensive odour.

2d, Potatoes grown on soft loamy land have been found to be more affected than on upland soils of a dry light description, and the greatest failure seems to be in the variety termed buffs. In several instances the kidneys are sound, but not entirely so. The species termed Perth reds, are also safe, though grown alongside of dons and kidneys that were partially diseased. I have not learned that the previous cultivation, or the different kinds of manures, have had any particular influence in promoting, retarding, or preventing the disease; and I have no information as to potatoes recently obtained from seeds, and incline to think there are some such in this quarter. When the weather and land are very dry at planting, the potato succeeds best here with well fermented dung, but not unfrequently the reverse in such seasons.

3d, By far the greater part of the potatoes grown in this district are stored in oblong pits, immediately on their being taken up, and receive a light covering of straw, and about a foot deep of earth. In almost every case, a part is stored in outhouses for family use, and allowed to remain uncovered, to dry, till frost sets in. I have seen some

instances this season where no symptoms of disease appeared among such as were stored in this way, while taint, more or less, made its appearance among those that were pitted. It has also been observed that more of the potatoes were diseased in the middle of the heap, than on the outside or bottom.

The greatest failure I have heard of among the potatoes in this quarter is at Fasque, where the disease made its appearance shortly after they were pitted, and has destroyed more than one half of the crop. From what I have seen, I hardly think the diseased tubers communicate infection to those that are constitutionally sound, though it seems pretty generally believed they do. This could be very easily ascertained by mixing a few of each sort together. My own potatoes, last season, being on the higher part of the farm, were late, and a light crop, but seemed sound, and have kept well. I purchased a quantity at the sale at Mains of Fasque, which had a fine appearance; but they were not long pitted when several were discovered to be diseased, and the contagion does not appear to have increased.

No. 83.—Mr James Farquharson. Galloqueline Farm, 28th March 1846.

1, The disease in this parish, Fordoun, has been partial, and to a very limited extent; consequently no particular observations were made as to the appearances of the crop while growing.

2, The writer planted three acres on dry light soil, on 25th April, part golden dons and buffs, from a neighbouring farm, and part golden dons from his own farm. The whole were sold to the inhabitants of Auchinblae, and removed from the ground for immediate use during August, September, October, and November. The quality of the potato was very excellent, and had not the slightest appearance of taint or disease of any kind. Planted other three acres on similar dry soil, a few hundred yards to the north of the last, on 5th and 6th May, part golden dons, the same as in the other field from his own farm, and part buffs and Americans from a farm in a higher and later district in a neighbouring parish. Suspected nothing wrong with the crop while growing, but when taken up for storing, found that the *dons and buffs* were considerably affected, and the Americans very slightly so; stored the latter on the field in the usual way in long narrow bins covered with hill scaddens (thin turf) and earth. These have kept well, and, except a very few, are quite sound. The *dons and buffs* were put into a granary, and have been carefully hand-picked three different times, and will require to be again gone over, before being used for planting. About one-sixth part has been affected, but, except the expense of labour, the loss is trifling, as the tainted potato, when taken in the incipient stage of the disease, is quite as good for use as the sound one.

Raising potatoes from the seed is very little known, or at least very little practised in this part of the country; but the changing of the sets or tubers from one district to another, is almost universally followed.

3, When disease (murrain, dry-rot) does exist, thin layers on a dry floor is the most effectual mode of preservation. A tainted tuber laid close to a sound one will not affect the sound one; but in a large heap it will.

4, Care should be taken not to plant on an *exhausted soil*, even with an abundance of good manure. If the weather will permit, plant *early*; the return may be less, but surer, and of better quality. The potato plant likes warmth and dryness, and requires the *whole summer*. If the ground is dry, the tubers should be cut at least a week before planting, so as to let the wound heal or dry, and thus prevent the soil from abstracting the moisture from the set. If the ground and manure are moderately damp, then the tubers may be planted newly cut.

No. 84.—Mr James Vallentine, Secretary to the Fettercairn Farmers' Club. Woodmyre Cottage, 10th April 1846.

First, In regard to the period of the season when the disease made its appearance, I may state generally, that in this quarter there was scarcely any perceptible difference in the stems of the diseased from the healthy tubers, and it was only in the process of digging that the extent of the taint became apparent, from the dark-coloured spots

upon those affected, resembling the appearance made upon the skin of an apple by falling to the ground.

Second, It appears to me that the disease prevails most in soils liable to be much affected by sudden changes in the atmosphere; such as very wet or very dry land, or where the ground has been overcropped. In well-drained lands, with a good depth of mould, comparatively few failures have occurred. More seems to depend upon the state in which the manure is applied than upon the particular kind used. Where court-yard or street dung has been laid upon the same lands for a long period, a dressing of guano or gypsum will be found of great advantage: indeed, I have not heard of a single failure after any of these two manures; arising, I have no doubt, simply from the change of application. Court-yard dung is often used in an ill prepared and too hot a state. I am not aware that one sort of potatoes is less subject to disease than another.

Third, In regard to storing, the most successful mode that I have seen practised is to deposit the potatoes in an airy position, covering them with straw or turf in such a way that the covering may be easily removed every dry morning, and put on at night, for eight or ten days, at the end of which period, the sound potatoes will appear quite dry, while the tainted will have a dark wet colour. The pits or heaps ought then to be carefully picked and turned, and finally closed up. The diseased tubers should then be removed to some shed or granary, where they can be exposed to plenty of air through the day, and covered with a little straw at night. This will check the progress of the disease, and render them useful food for cattle or pigs.

My own impression is, that the peculiarity of the three past seasons has had more to do with the failure than any thing in the tubers themselves.

KINROSS-SHIRE.

No. 85.—Mr David Syme. Kinross, 6th March 1846.

Although I am not a farmer, and have no practical knowledge of farming, I think it right to send the following account of my experience in potatoes, a subject to which my attention was drawn by the accidental circumstance of having a small piece of ground, which I wished to break up, in order to improve the grass. This ground consisted of about half an acre of old pasture, eight or nine years in grass—light sandy loam upon sand and gravel—365 feet above the level of the sea—fully exposed to the east, and near a large lake, (Loch Leven.) It was trenched in the end of 1844, to the full depth of the soil, and planted with field potatoes in the spring of 1845, *without manure*, with *reds, buffs*, and another kind, called by the gardener, droppers. There were also some early garden potatoes, dark kidneys, and white early potatoes, and these were planted *with manure*, with other vegetables, in a corner of the ground. These early potatoes were a good crop, and appeared quite healthy; but though the others came up well, and grew luxuriantly for a time, I observed, between the middle and end of August, some irregular brown patches, mostly of a circular form, over the small field, and on examining the tubers, found them seemingly healthy, but small; and on examining them some weeks later, they had not increased in size. Previous to this blight (for so I considered it) cold easterly winds, with a good deal of rain, had prevailed. These brown patches spread slowly, and encroached on the healthy green plants in their vicinity, the greater part of which, however, retained their vigour till the tubers were full grown. At length the stalks of the whole decayed away, but, perhaps, partly from frost at night; and in October the crop was lifted; the small potatoes picked out, and kept apart, the rest of them carefully dried in the open air, and then placed in pits, without flues or any kind of ventilation. At this time all the potatoes looked sound, but, on paring off the skin, a few of the *buffs* and *droppers* were evidently affected by the disease, though slightly, while the reds seemed free of it.

In the course of the winter the potatoes were taken from the pits from time to time for use, and as the season advanced, a greater proportion were found bad, but still fully

four-fifths of them remained sound, and were of excellent quality. The pits were opened in February, and the whole picked, when only a small quantity were found quite decayed, thrown away, and the rest pitted again.

The early potatoes reserved for seed have turned out not altogether free from the disease.

The field potatoes have certainly been better, and have kept better, than most others in this neighbourhood—which I attribute, 1st, to their having been planted earlier; 2d, to the freshness of the soil, and the absence of manure; 3d, to their being perfectly ripe and dry when pitted. The want of ventilation was probably also in their favour.

I have prepared the remainder of the small park, one and a half acres, precisely in the same manner, and mean to try potatoes again, using new kinds from uninfected districts, and also, by way of experiment, a few of the former crop.

No. 86.—Mr Andrew Dodie, Factor to Sir Charles Adam of Blair-Adam. 16th March 1846.

Answer to query first.—It was in the month of September that reports reached this district of the country, of the taint that had affected the potato crop. At that time I never saw the crop looking better, or promising a more luxuriant return. Little of the disease was observable here until the 9th October, on which day we had a very strong gale of wind. The tops or shaws, previous to that day, had not suffered the least decay, but immediately afterwards they all at once decayed, the same as if they had suffered by a severe frost. After this, almost every field was found to be more or less affected, the tainted tubers being easily distinguished by dark spots on their ends; and the diseased parts, after being boiled, presenting a dark, soft, and watery appearance.

Answer to query second.—In regard to the varieties that have been less affected than others, as far as my observation leads me, I am of opinion that the old red potato has suffered less than most of the other kinds usually planted in this district. There is also a kind which I had planted, called American early, which, although it did not escape the disease, still suffered comparatively less than some of the other kinds, such as buffs, blues, &c. As to whether potatoes recently raised from seed were less subject to the disease than those which have been long raised from sets or tubers, I cannot speak with any certainty. As far as I am able to judge, (moss land excepted,) I do not think that any peculiarity in the soil, (excepting altitude,) or the kinds of manure used, appear to have had any influence, in either promoting, retarding, or preventing the disease. The crop on moss lands certainly suffered less than on any other kind of soil. On a field I had planted, there is a narrow stripe of moss land running across the middle of it; the tubers on this part of the field were little, if at all, affected, the remaining part of the field, under the same management, was all affected, although none of it had been under a potato crop for the last twenty years, and was newly furrow-drained. In confirmation of my opinion, that no peculiarities of soil, manures, &c, had any thing to do in causing the disease, I may mention that, on this estate, one farmer, (Mr Tod) a most intelligent and enterprising agriculturist, planted a field of thirteen Scots acres with potatoes, after oats, the field having been, for the three previous years in grass; the soil, a fine dry sandy loam, in every respect well adapted for green crops. One half of the field was manured with well prepared dung the previous autumn, and ploughed in, and when planted, about two cwt. of guano per acre, were added. The other half of the field was also manured with well-prepared dung, and applied in the drills when the potatoes were planted. The whole were planted at the same time, and early put in; but both parts of the field were very much affected with the disease; and it was impossible to say whether the autumn or spring manured was the worst. The whole of the field, previous to the gale of wind formerly noticed, had the finest appearance I ever saw, and was sold by auction in August, at upwards of twenty guineas per acre. After the disease made its appearance, Mr Tod generously relieved the purchasers (who were chiefly the working classes) from their bargains, and thereby lost L.200. On the contrary, another tenant on this estate, whose farm is on a higher altitude, had a field of potatoes manured in the drill in the

ordinary way, the soil retentive, and in want of furrow-draining. On this field the disease scarcely made its appearance, and had it not been known that such a thing was in the country, the tenant would not have known that any disease existed in his crop.

Answer to query third.—The mode adopted by me in storing the crop was as follows:—Being fortunate in getting dry weather to lift, I pitted them on the surface of a dry piece of ground, mixing a little earth with them—the pits about three and a half feet wide at bottom—covering them with dry straw, with about two inches of earth above, then above the earth I thatched the pits with straw, secured by ropes. Had I allowed them to remain undisturbed, I believe the greater part of them might have been saved; but in the month of December I thought that it would be of advantage to turn them over, and remove any that were decayed; on doing which I found that about the twentieth part had given way. These I removed, and again covered in the manner formerly described; and in February, on opening the pits, for the purpose of again turning them, I found that the one half were entirely decayed, which I chiefly attributed to their being turned over and exposed to the air in December, and I am now the more convinced of this, in consequence of one of the tenants on the estate, in storing his potatoes, having laid down drain tiles from end to end of his pits, as well as across, and placed them upright, so as to cause a free circulation of air through the pits, and every potato, in a short time, gave way, and the pits sank in.

In future (if we again shall be visited by the disease) I mean to adopt, and would recommend, although at additional cost, that the bad should, as much as possible, be separated from the good, by hand-picking, at the time of lifting, and given to the feeding stock, and the good put in narrow pits, as dry as possible, and mixed with a little earth, sand, or lime, with a very light covering of earth, and invariably thatched on the outside with straw, so as to prevent moisture sinking through the covering of earth; and the potatoes should not afterwards be turned over.

In separating the tainted from the healthy tubers, it is, no doubt, next to impossible to do so effectually, yet, if they were stored in the way I have recommended, I do not think that a few bad would materially hurt the good ones.

I have only further to remark, that until within the last fifteen years or so, no failure in the potato crop was ever heard of. Previous to that time, it was of no moment whether the sets were cut three weeks before planting, or on the day of planting—whether the manure was properly decomposed or not, or how applied—whether the seed time was dry or wet, early or late—it was all the same, no treatment whatever prevented them from growing, except exposure to frost. Latterly, however, year after year, (some favourable seasons excepted,) the potato has been evidently declining, and, from some cause unknown, the sets undergoing decomposition in the ground after being planted; which decomposition, as far as I have been able to ascertain, always takes place when the knife passes through the potato. Would it not, therefore, be adviseable to give up altogether cutting the potato into sets, and to plant them entire? This plan may not restore the root to its pristine vigour, but if it does not, I believe nothing will. It appears evident to me, that the cutting of the potato into sets, from year to year, for such a length of time, must have weakened its vegetative powers; and, consequently, may not the delicacy of the potato be attributed chiefly to this, arising from the bleeding that it undergoes, after the process of cutting?

In closing these few hurried remarks, I would earnestly recommend to the farmer to give up using the knife altogether, for the next two or three years, and plant his potatoes whole, placing a quantity of earth between the manure and the seed.

Should this plan be generally adopted, and succeed in restoring the potato to its former vigour, a great boon will be conferred on this country in general, and on the working classes in particular. Should it fail, we cannot be in a worse position than we are at present, as far as regards the potato crop. I, at least, for one will make the trial.

KIRKCUDBRIGHTSHIRE.

No 88.—Mr David Tennant, Howwell, Kirkcudbright, 7th May 1846.

1st, Regarding the period of the season when the disease first manifested itself, I would say from the middle to the end of September, on my farm. The first two carts we raised from the field for the use of the house, did not seem at all affected, and it was not till harvest was far advanced that the disease became visible. With respect to the state of the weather, it was in general stormy and wet—particularly one Monday in the end of June, there was a remarkable storm of wind and rain—such as is rarely met with at that season of the year. It tossed the stems very much about, and made openings in the surface of the drills, into which the water entered, and, in my opinion, hastened, or assisted the disease. In a general way, the stems and leaves did not show much difference from ordinary years. There were some dark spots in the fields, but, on examination, the roots did not seem much more diseased than the rest of the field. The taint in the tubers consisted of dark-coloured spots over the surface of the potatoes, immediately under the skin. 2d. Whether any varieties, commonly cultivated, have escaped the disease?—I am not aware of any particular variety that has entirely escaped. Generally speaking, the newest and freshest varieties have been least affected, and the old cultivated varieties the most. I cannot say that the condition of the soil seemed to have much effect on the disease, or the qualities of the manures used. I considered them rather worse where the land was dampest, and they were much the same with guano or other manure. 3d. With respect to the mode employed in storing the potatoes. I believe it was in conducting that operation where the greatest difference prevailed, and where some were much more successful than others. Those who had the good fortune to put their potatoes from the field into airy outhouses, to completely dry them, and, after raising was over, turned them over with the hand, picking out the tainted ones, and laying them aside, to be as soon as possible used by the live stock on the farm, received, at least, the feeding value of the crop. Where houses on the farm are not convenient, by putting them in small heaps in the field, and carefully thatching them with straw to keep them dry till after raising time, and afterwards hand-picking them, and putting the tainted ones aside to be first used by the stock, and the sound ones into narrow pits on the surface of the ground, well covered with straw, and a thin covering of earth, they were in the next best state. Those who pitted them from the field in the usual way, at raising time were worst off. The great desideratum appears to be, to have the potatoes as dry as possible, and as soon as possible so previous to covering them in a pit, or putting them together in large quantities.

No. 89.—Mr Francis Maxwell of Terregles Bank. 23d May 1846.

The disease in the potato crop did not attract attention in the neighbourhood of Dumfries until about the middle of August, but by the end of the month, whole fields were affected with the disease, and scarcely any were free from it. In the district around Castle-Douglas, the disease did not become general until a fortnight or three weeks later, while the cold wet lands of the district between Dumfries and Castle-Douglas, were seemingly free from the disease, even in the middle of October. All those districts were, however, more or less affected before the potato crop was taken up.

The reason why the potato crops of the different districts were thus progressively affected, seems to be, that the potato was only liable to disease as it approached to maturity. The disease, consequently, first showed itself in the earlier and drier soils, and extended progressively over the later and wetter soils of the district. The fields near Dumfries, which were first affected, were those on a dry sandy sub-soil. Where part of a field was wet, the potatoes growing thereon were less generally diseased than in the other parts, but proceeded more rapidly to entire decomposition. Potatoes growing on peaty soils, were said to be little affected with the disease; and a gentleman who had a considerable quantity planted in Locharmoss, told me, that they

were quite free from the disease. The kind which he had planted were *prince regents,* which have generally *been affected with the disease.* A case of a contrary nature came under my own observation, where potatoes planted in pure peat, of *kinds liable to the disease,* were much affected. In this latter case, the land in which they grew, had been well limed at a recent period, whereas, in the former case, the ground had never been limed, which might account for the difference.

The weather, so far as I remember, was dry, with some thunder, and a slight frost for a night or two, when the disease first showed itself about Dumfries. In other parts of the district, the weather was become rainy before it appeared. Excessive wet would not account for the disease, seeing that the *drier* soils were those on which it first appeared. As the disease took probably three months to spread itself generally over the country, it would seem that its cause must be looked for in some thing different from atmospherical influence.

The disease first showed itself by a premature withering and decay of the stem and leaves of the potato. In some cases, potato stems that were in a state of extreme luxuriance, withered, as if from the effects of frost, but were of a brownish colour, and without the softness and flaccidity which frost causes. On uncovering the roots, instead of their usual healthy colour, their outside was of a brownish colour, and much decayed, in particular the part nearest to the stem; the potatoes attached thereto seemed at first little injured, but after the disease had continued a short time, the outside of the large potatoes were found to be in many places discoloured; and in cutting into such places, there was found immediately under the epidermis, a brown decaying matter, but which did not go deep in the substance of the potato. After the disease had existed a considerable time, the substance of the potato became more generally affected, and had very much the appearance of the former disease of the potato which showed itself in spring. The young and very small potatoes attached to diseased roots, were seldom, if ever, affected. Instead of the disease having been caused by the absorption of diseased or fungus matter by the leaves, as is generally supposed, it is equally probable that the disease commenced in the root of the potato, and *is only a modification of the spring disease.* The appearance of the diseased potato is very similar in the two cases. In the present disease, the potato, as it approaches maturity, becomes diseased before it is taken out of the ground, whereas, the former disease was seldom detected in the potato, until the time of planting. Instances, however, occurred, in which the disease showed itself at an earlier period, even at the time the potatoes were taken out of the ground.

As in the former disease, some kinds of potatoes were much more liable to fail than others, so in the present one, some kinds here have been almost totally destroyed, while others have been comparatively uninjured. The kinds most liable to suffer from the former disease, were precisely those most injuriously affected by the present one. The more farinaceous kinds, and those best adapted for the table, were most liable to the disease; the more waxy and coarse-eating potatoes were less injured. The kinds called in this district cups, prince regents, highland chieftains, &c., suffered little from the disease.

The kind of manure applied to the crop, or the previous mode of cultivation, seem to have little influence on the disease. Of two fields near Dumfries—both of a dry sandy soil—the one had been broken out of grass the previous year, (under which it had been for a long time) was well manured with good farm-yard manure, and the potatoes planted uncut. The other field had been managed under the alternate husbandry in a five-years' rotation, manured with farm-yard dung and *guano,* and planted with cut sets. Both fields were equally diseased.

In storing the potatoes, the principal thing for their preservation was, to have them as dry as possible when put together, and to keep them so. Whichever mode of keeping secured this the more effectually, was proportionably successful. When in pits the potatoes kept better, if covered with straw alone, than if also covered with earth. One farmer used sheep flakes inclined against each other, and thatched as a roof for his pits—leaving four or five inches of a vacancy above the potatoes for ventilation, and had the bottom of the pit well drained. The potatoes kept particularly well in this way. The same farmer used lime to mix with a part of his potatoes without any beneficial effect, but rather the contrary.

The farmers in the district seem to have taken the precaution as much as possible, of planting the kinds of potato less liable to disease, which, with the generally favourable weather at planting time, will, it may be hoped, insure a good crop. It will be observed, that the potato requires to be approaching to maturity, before it becomes susceptible of the disease; and that even among diseased potatoes, the young, or very small potatoes, are sound. If, then, the precaution is taken of planting the kinds of potatoes less liable to disease—of planting the very small potatoes of the more delicate kinds—of the yearly late planting, of the kinds intended for seed, or cutting off their stems, so as to retain them in an immature state—under these circumstances, I have no doubt the potato will be restored to a healthy state, and continue to be a useful object of culture.

LANARKSHIRE.

No. 90.—Mr Robert Findlay. Easterhill, 17th March 1846.

1st query.—The disease in the potato commenced in my fields about the middle of September, and no symptoms of disease appeared either on stems, leaves, or tubers a week before, as they were most carefully examined by the most extensive and experienced potato dealer in this district, along with my head ploughman at the time; and I had their assurance that they could detect no trace of the epidemic. Although there was a low temperature, I have seen many seasons less favourable in various respects; and, in point of fact, I never had so fine a crop both in quality and quantity, as mine was last season within a week of the commencement of the disease.

2d, The red yam and lumpers that had been planted among the yams for the farm horses, were the varieties least affected in the field, and in the garden, the American early. I had none recently raised from seed, in so far as known to me; but for these thirty years I have never planted potatoes of my own growth, always bringing seed potatoes from the approved upland districts. The greater part of my land in potato crop, had beed recently furrow-drained and limed, and been some years in pasturage, and never had been in potatoes till last season. It was very richly manured with horse and cow-dung, and is strong fertile land. I thought that it was too heavily manured, and this season I am *ploughing in* the manure when the weather will permit, and using less of it, so that the error of last year (if error it was) may be avoided, and that the seed shall not come in contact with the dung. I have not found that my experiments with guano, for potatoes, were successful, though most eminently so with turnips. I have universally used the best horse and cow-dung, and never had a failure till last season.

3d, I only stored (in narrow pits) the apparently sound, at digging time. Those stored in dry sheds for immediate use, and exposed to the air, did not decay so rapidly; and those that were, as an experiment, left in the field *undug* till now, have kept still better, but if there had been severe frost, they would have been destroyed. When I mention that out of 1500 Lanarkshire bolls, I have not been able to sell a single one fit for human food, the best being only fit for hogs and cattle, when steamed, and a great part ground for the farina, as rapidly as I could get accomplished, in order to save something out of the rapidly decaying mass, you will infer that my opinions as to the best modes of peservation can be of little value. As I addressed Professor Johnston on the queries sent by Mr Fleming of Barochan, Dr Greville, and him, I shall not trouble you further at present.

No. 91.—Mr R. Murdoch. Cranhill, 11th March 1846.

1st, In our district the disease did not manifest itself during the period of green sale. It first appeared after harvest, and at the usual period of pitting. The season had been rainy and continuedly wet for several months, scarcely dry for twenty hours at a time during that period, and the nine months preceding these rains had been dry beyond all precedent during the same calendar months. The stems, leaves, and flowers, had been entirely decayed before the taint appeared. Where not ripe they had been quite cut down by two nights' frost. These ten or twelve years past it has been quite a rare occurrence to meet with a field of potatoes exhibiting any quantity of

flowers. The tubers, when tainted, appeared at first discoloured in parts with brownish yellow.

2d, Cups have certainly been less affected than others, and, till now, have been planted here to a very limited extent, being thought a very coarse potato. Potatoes here have rarely been raised from seed, and am not aware, that where so raised, they have been less subject to disease than others. I am satisfied the condition of the atmosphere, and character of the seasons, have great influence in inducing or modifying the disease. Several past seasons, in spring, I have particularly observed the seed tainted a short time after planting, sometimes a third or a fourth of the seed getting altogether putrid—occasionally partially tainted, or the progress of the taint not being so rapid; great proportion of the seed sent out shoots, which, during the continuance of taint, were very weak and sickly, but if the seed continued, while tainted, to afford nourishment to keep the plant alive until rooted in the soil, and deriving nourishment therefrom, and from the manures, thereafter the growth became luxuriant, and the produce abundant. I have several times seen part of a field so far gone, to the extent of one-third or nearly one-half, as almost to have been induced to plough them down, produce an equal, and sometimes more abundant crop than the untainted part of the field. I have invariably observed these changes in the seed and vegetation of the plant, very much dependent on the condition of the atmosphere, and especially the alternations of wet and dry, and also the frequent change of extremes in the temperature. Last season, after planting, the temperature for some time was moderate—there was very little taint in the seed, and the shoots came up rapid and beautiful. After being a few days through the ground, the temperature became cold, and continued cold and dry during two months. During this period the stems and leaves seemed curled, and were very stinted and slow of growth. Thereafter rain coming (the ground being very dry) with fine warm temperature, the growth was rapid, and the crop became luxuriant, and but for the taint would have been found to have been much more abundant than any former crop. I have no doubt that high fermentation of the manure materially promotes the disease, especially if a violent and low change of temperature occur when the fermentation is great, or soon thereafter. Last season the fermentation was greater, perhaps, than ever seen There was also one night's frost, shortly after midsummer, very severe, which, though injuring materially the tubers, did not kill them, and the after growth, though very great, could not render the frosted part of the potato sound, rapidly enlarged its size, and induced a constitutional delicacy and tendency to the disease, already begun in the potato by the frost.

3d, Potatoes stored in narrow pits, well ventilated, the unsound ones having been carefully gathered out at storing, have kept as well as in many past seasons. But where pitted wet, the unsound not gathered out, and the pits large, they have kept very ill, and in many cases have been entirely lost.

No. 92.—Mr Angus Ross, Overseer to Mr Menteith of Stonebyres. 18th March 1846.

Regarding our potato crop at Stonebyres, as far as known to me, we had the greatest failure in proportion to space and quantity, in this neighbourhood. I may say that ours was a total failure, with few exceptions. As to when the disease commenced, I can only say that we did not observe any thing wrong till after the great flood in September; but a very few days after that, we observed it, and so rapid was its progress that by the usual time of lifting the potatoes, our crop was so completely gone, that we were induced to try every method that ingenuity could devise, to save some of them. It is of no use to state the various methods tried, as none of them were successful. If I can say that any was safe, it was those left in the ground till the end of last week, and on close examination, when the potatoes were uncovered, I found that where the potatoes were placed in contact with undecomposed manure, they were in a complete state of putrefaction, while the few found clear of the manure, were quite good and sound. The sorts which formed the principal part of the crop, were what are called buffs and rough reds, but amongst these named we had a drill of another sort, to which I beg respectfully to call your attention. As a good deal has been said and advised on the potatoes being raised from seed, I beg to submit the following observations on the potato above alluded to. This is a round white potato, very much resembling the American early, which has been grown at Stonebyres for the last thirty-two years, and left me by my predecessor in the garden here, requesting me to make trial of it, which

I did two years ago, and found the same to be a most prolific bearer. From this I was induced to plant a drill of the same potato in the field, under the self-same treatment as the rest of the potatoes, and no particular notice was taken till the time of lifting, when we found, to our utter astonishment, that our old friend stood uncontaminated in the middle of the field. Observing this, I, without any preparation whatever, got it pitted in the usual manner, and lifted the whole on Friday last, quite sound and free of any disease as far as I can judge.

I beg also to state, alongside the latter potatoes were planted a new potato said to be raised from seed, which was found, on examination, to be affected with the disease, I should say, rather less than the general crop. The above are facts which I can vouch for, and how will scientific gentlemen reconcile them with the idea of raising potatoes from seed I know not, but as I am making preparations for various experiments on potatoes this season, I shall be most happy to communicate the results to you at the proper time.

No. 93.—Mr North Dalrymple of Cleland. 231 March 1846.

1st, No particular observations seemed to have been made.

2d, The early varieties have nearly escaped the disease. The dons (it is believed) would ere this time have been all lost, had they not been consumed. About one half of the cups and other varieties have rotted. The condition of the soil, and the kinds of manure seem to have no effect.

3d, Turning frequently, and separating the diseased from the sound.

No. 94.—Mr Francis M'Minn, Secretary to the Carluke Agricultural Society. Carluke, April 3, 1846.

Query 1st.—The disease made its appearance about the early part of September, and immediately after a severe hail blast and high winds, the leaves lost all their natural greenness, and appeared as if frosted and dry. The disease seized the leaves and stems first, and then descended to the roots, for not till the phenomena now stated was the spot, or "tick," in the potato discerned. In wet soils the taint was observed in the roots about two weeks earlier than in drained and dry land.

Query 2d.—Buffs and blues most particularly failed, rough robs, smooth reds, and Irish cups were much less affected, and, indeed, little taint was seen in smooth reds and Irish cups at all. Only one instance of potatoes from *seed* is known here, and no disease was discerned in them at all. Buffs, blues, and reds, were among these seeds, notwithstanding they have remained in the ground till the usual time of digging in October. The rest of the field was planted with sets, and all failed. They were manured and cultivated in the same manner. Damp soils promoted the disease, no kind of manures prevented it. Where the soil was drained and dry the taint was no longer in showing itself. New land had no particular effect in promoting, retarding, or preventing the disease.

Query 3d.—The modes of storing potatoes here are generally pitting, &c., but last season a great number left were in the drill, and found to keep better there than in pits or storehouses; and where the ground was drained and dry, no more loss was sustained at the end of last month, than appeared in October last. Some individuals mixed lime with the potatoes at pitting time; but this had no effect in preserving them; others frequently separated the diseased from those supposed to be sound, but the disease still went on. One farmer tried the washing of 3 bolls of rough reds and smooth reds, and these being laid aside kept well during winter.

LINLITHGOWSHIRE.

No. 95.—Mr George Whittet. Hallyards, Kirkliston, March 1846.

Answer to query 1st.—About the middle of September, I, along with a person who intended to purchase them, minutely examined my potatoes. We at that time found them perfectly sound. Some days after a heavy fall of rain took place, followed by cold weather; and when I lifted, for storing them, in the beginning of October, they were found diseased. I observed that the leaves and stems very rapidly decayed, and that this year there were very few seed ' apples."

Answer to query 2d.—I had planted on this farm, as well as on one near Edinburgh, dons, buffs, and blues. The seed had all been brought from a high cold district. I found, upon lifting, that they were all very much tainted. The buffs worst, blues next, and the dons least. The crop on all the fields was very good, being on land after a crop of oats, succeeding two years' pasture with sheep. Part of the land was dunged with horse and cow manure—part with home-made manure. I could perceive no difference in the taint, except on part of a field which was manured with dung not much rotted, and was the worst. I observed in my neighbourhood, that the poorer the land, and the worse the crop, the less taint there was.

Answer to query 3d.—I employed all the different modes in storing the potatoes:—in houses; in pits covered in the usual way, with holes for ventilation; and in very small pits covered only with straw, but nothing would preserve them. I turned them frequently—separating the good from the bad—but without any effect. The only chance of preserving tainted potatoes (in my opinion) is to store them in exceedingly small pits, and cover them lightly with straw; and even then, to give them as much air as possible, from the very first day they are pitted; and after all this is done, the potatoes will soon become dried, but unfit for human food, though they do well for cattle. I have seen hot lime tried upon potatoes laid very thin upon a wooden floor, and in pits ventilated with drain tiles, but the results were equally unsuccessful.

No. 96.—Mr James Walker. Kilpunt, Bion, 27th March 1846.

From all my observations, and from what I can hear from practical and scientific men, the cause of the taint still remains a mystery; the opinions too, of practical men, are often at variance, tending rather to involve in obscurity than to throw light upon the subject. I hope, however, that time will disclose much that is yet undisclosed. In the mean time, I would recommend all practical men to study closely the nature of the potato, as in the now improved state of agriculture, with heavy manuring, &c., it may have become so delicate in its nature as almost to render extinct its vital powers; and that it is far more delicate in its nature than it was fifteen years ago, every body will admit.

To the best of my recollection, I noticed the disease in the tubers about the middle of September; previous to which time, however, the stems had become quite blackened and decayed; and I date the declining health of the tuber from the time I observed the decay in the stem. I would say the disease began to take effect generally from the first of August, previous to and about which time (1st of August,) the weather was very wet, with little sunshine. The stems and leaves which, in all my experience, had never been stronger and more luxuriant after the wet weather, gradually lost their greenness and healthy appearance; and in some varieties, which I will afterwards notice, the greenness remained till the first of October. One thing was very remarkable, I observed few flowers, and almost no apples upon the plants. I had red early not affected at all with the disease, growing in the same field with buffs and dons, of which there were four-fifths diseased. I had Irish cups in the same field with little disease, say about one-sixth. The buffs and dons were changed seed from a high country, the early and Irish cups I got from my near neighbours. The field in which the above varieties were planted was all manured alike with about 25 tons of court manure, and 4 cwt. guano, to the Scotch acre; it is generally a rich loam, but I observed the disease less virulent in spots of the field that were clayey. I stored the red early and Irish cups in the usual way, the buffs and dons I stored partly in houses about three feet thick, and partly in narrow bins or pits; these pits were covered thickly with straw, and *no earth upon them at all.* I soon found those in the houses beginning to heat; and was obliged to spread them till they were about a foot in thickness, and even then many of them rotted entirely. Those in pits kept without turning worse for three months, till I got them all consumed with cattle, but have no doubt they would have kept, even in the diseased state, till now. Wherever the disease existed in a potato it gradually spread itself into it; but where no disease was, I observed the potato remained sound in the midst of those effected with taint. No plan was so efficacious for preserving the unsound as narrow pits, never even turning them, for I found, whenever they were stirred, they began to consume.

No. 97.—Mr John Dudgeon. Almond Hill, May 1846.

1st, The period at which the disease in the potatoes first manifested itself was betwixt

the last week of September and first week of October; no particular appearance was observed, except the stems and leaves decaying more suddenly than in former seasons.

2d, Potatoes most effected were the blues, being fully a half diseased; buffs and dons were not so bad. I had also a few Dutch early potatoes, which, at the time the buffs were lifted, exhibited no-symptoms of disease; but in the course of eight days, when lifted, there was scarcely a sound potato; in those from wet land the disease appeared to be fully worst.

3d. The modes by which I stored my potatoes were, by putting them into a common pit, laying them on the surface (that is, not deepening the pit as is generally done,) covering them with straw nearly a foot thick, with 2 to 3 inches of earth, so as to allow of ventilation. The result was, that I did not consider the healthy potatoes put into the pit to be much injured, although, in some parts, where the straw had not been put on a proper thickness, rain had gone through and caused rot in a few. I also stored about 20 bolls into a granary, which I ordered to be turned over three times, picking out all the diseased ones; and this I consider to be fully the best mode I adopted for securing them, although it could only be done with a small quantity, accommodation for a large quantity not being easily obtained.

NAIRNSHIRE.

No. 98.—Mr Alexander Walker. Brightmony, 25th March 1846.

As I have never seen any potatoes affected with the disease, I am unable to give any opinion. This county and Morayshire are free from it. As far as I have heard, a general opinion prevails here, that it, in a great part, was owing to the cold wet season, especially where the land was strong and heavy; but how far this opinion is correct I cannot say.

No. 99.—Mr William Mackintosh of Geddes. 25th March 1846.

With respect to myself I know nothing of the disease from experience, for my potatoes have been good, and continue to be so, without any particular management, and from all I can hear, this is the case over the whole county of Nairn.

No. 100.—Mr James M'Killican. Piperhill, Cawdor, 24th March 1846.

1st, As to the manure. And I put this first, because I believe, from my own experience, that the success or failure of this crop depends in a very great measure on the state of the manure at the time it is laid down. In the year 1840, I planted my potatoes with rank manure fresh from the fold, and that year my crop was a complete failure. My attention being in this way directed to the subject, I next year made a dunghill of the summer and harvest manure, which I first turned about Christmas, and again about three weeks before the crop was planted. A thin layer of clayey soil found on the farm was put on as a covering to preserve the dunghill from the weather, while another was put underneath—the dunghill both times being cut very small—and that year I had an excellent crop, with the exception of about half an acre, which, being manured with rank dung as an experiment, completely failed. Ever since I have prepared the manure in the same way, and have had excellent crops, without a single failure in the field, except half-a-dozen of drills which I have generally dunged with the rank manure, in consequence of a scarcity of the prepared, and invariably these drills have failed.

2d, The time of planting. I consider the time of planting, as well as the state of the manure, a very important matter. I had observed that the earliest planted potatoes were generally a sure crop, and that the latest planted were an uncertain one. In consequence, I have for the last few years commenecd planting my potatoes about the first of April, when the soil is in its natural cool state. I am persuaded that when the drills are exposed for two or three days to the heat of the sun, in dry weather, it is very injurious to the crop. Consequently, the sooner the manure is laid down after the drills are opened the better. I would, from my own experience, recommend potato planting to begin about the first week of April.

3d, As to the seed, I have used the kinds common in this part of the country, and

think a change necessary in this as in every other kind of crop; and further, that it is of advantage getting the change from a higher, or Highland district.

I have used sets or cuttings, and not the whole potato, and consider it of importance that an experienced person—one who knows the proper potatoes to choose, and the proper eyes in the potato to select, should be employed in cutting the sets.

4th, The state of the soil. If the ground is clean and in good condition, I am of opinion that the less ploughing it gets, the better for the potatoes. For the last three years I have only given the potato-ground one ploughing after the crop of oats is taken off the ground, at the latter end of harvest.

5th, Storing the potatoes. As I have had no failure after the potatoes were stored, I continue to use in this respect the ordinary method. The potatoes are put in sand-pits, with from three to four bolls in each pit, with a layer of straw and some divots over them, and above these from 15 to 18 inches of earth. A piece of wood covered round with straw, reaching to the potatoes, is placed as a ventilator in the centre of each pit.

ORKNEY.

No. 101.—Mr Thomas Hutton. Benholm, Kincardineshire, 20th March 1846.

As the Society will likely receive reports on the potato crop in Orkney from some of the other members resident there, it is perhaps unnecessary for me to say more than that I believe the disease, so prevalent in many districts in Scotland, did not make its appearance in that county last season. I was there in the latter part of autumn, and found that, though from the excessive rains which had prevailed from the middle of September, the potatoes had rotted in the ground in some places, they were not affected with any other disease; and those potatoes which were lifted sound, have, I understand, continued so. I am in consequence getting a quantity of my Orkney potatoes to this farm for seed. I may only further mention, that notwithstanding the partial loss from rotting, the potato crop in Orkney last season was rather above an average one.

No. 102.—Mr Robert Scarth, Secretary to the Orkney Agricultural Society. Papdale House, 24th March 1846.

I am truly happy to be able to inform the Society that no disease whatever has ever been observable in the potato crop of the Orkney islands.

Large quantities of Orkney potatoes have of late years been carried to Berwickshire for seed, and I have never heard of any failure in the produce.

The potato crop in Orkney last season was most abundant: The tubers are of good size, clean-skinned, and fresh-looking; but the potatoes are generally not so good to be eaten as those of the south, being waxy, and scarcely ripe enough.

Whether we have to attribute our escape from this fearful loss to the poor, in the disease of their potatoes, to the climate, which does not permit the plant to grow rank or over-ripe—to the large quantity of salts from sea-weed present in our land—to the mixture of kinds in planting, (for our small tenants are not at all careful as to sorts)—or to what other cause, I cannot pretend to say.

I merely give you the fact, that neither now nor in former years have I observed disease of any kind in potatoes in Orkney, excepting a failure of the seed in a small field in 1840, and it is singular that the seed of those potatoes were procured from a stranger ship calling at one of our bays.

SHETLAND.

No. 103.—Mr Andrew Duncan of Tow. Shetland, 13th April 1846.

The potato disease was unknown in Shetland until some six or seven years ago, since which time its effects have been generally and pretty severely felt,

till last year, when it seems to have nearly disappeared altogether. The crop, however, was very deficient in quantity, owing perhaps to the unusual quantity of rain which fell during the summer and harvest months, coupled with the want of the usual degree of heat which prevented the potatoes from ripening. The writer of these remarks, who resides in the parish of Coningsburgh, cultivates a few potatoes annually for his own use, had not above one-half his usual quantity last season, which he ascribed to the causes already mentioned. His turnip crop was nearly a failure owing to the same causes.

His potatoes have never been affected by the disease in question in any perceptable degree, although it has prevailed year after year all around him, ever since its first appearance in the parish. He has uniformly recommended to his neighbours to try a change of seed, from which he has understood the best results have followed.

With respect to the cause of the disease he must of course profess the most perfect ignorance. It is not the common rot which attacks potatoes from bad keeping, or when they are not sufficiently protected from the frost, or when water is allowed to get at them. He shall therefore confine what further he has to state to such things as have come under his own observation, leaving to others to draw their inferences.

1. He would state that so far as he knows, the diseased potatoes are undistinguishable from the clean when they are taken out of the ground, and the difference is not observed for some time after—perhaps little attended to till the following spring, when a new selection of seed is required for the ensuing crop. The diseased potatoes are then distinguishable from the others by being marked with brown spots on the surface, though in other respects appearing perfectly sound. These of course are deemed unfit for seed, and properly, it is believed; and are consequently thrown aside.

The writer happened once to be present at the opening of a potato pit belonging to one of his neighbours, who had asked him for a few of his potatoes in exchange for some of his, which he knew or suspected were unfit for seed, though he thought they would do well enough to eat. The potatoes in the pit had all a bluish musty appearance, and the sproutings on such of them as were beginning to vegetate were of a wiry sickly appearance, plainly indicating the presence of disease, and the potatoes, when the trial was made, could not be eaten.

2. When the potatoes used for seed happen to be diseased, many of them never spring at all, and the shaws of those that do make their appearance above ground, have always a dwarfish sickly aspect, and never come to a proper size—and no tubers are produced, at least none of any value.

3. All sorts of potatoes are cultivated here. There is a pale red flattish potato of excellent quality, which, it has been said, never takes the disease. The same is said of a round purple-coloured potato, marked with several concentric circles of red inside, but the truth in either is perhaps not fully established. It is not usual here to raise potatoes from the seed, and no opinion can therefore be formed as to whether potatoes so obtained would be less liable to take the disease than others, or not.

4. The writer stores his potatoes in a small outhouse prepared for the purpose. His neighbours most commonly store theirs in pits in their corn-yards underneath their corn-stacks, where no wet can reach them.

Lastly, He always gives his potato land a moderate allowance of manure from the dung-pit, which he thinks tends to keep the ground in heat, as well as to improve the potatoes both as to quantity and quality. The people in his neighbourhood plant theirs without manure, generally in their best "intown" land, as they term it, and have always a good return when there is no disease in the case, though it is thought that the practice is injurious to the land by impoverishing it.

No. 104.—The Rev. L. M. Hamilton. Manse of Bressay, Shetland, 1846.

It does not appear to me to be of much consequence, either in staying the disease or in preventing its formation what variety of the potato be cultivated,

as all varieties seem to be chemically the same—but in my opinion a want of due attention to the chemical constitution of the root itself, has mainly caused the potato failure—so much to be deplored.

It is evident that farmers in general treat their land with this great leading object in view, viz—the raising of *grain* crops, and manure it accordingly. An opinion as to the evil effects of this and other perhaps not less injurious practices, I ventured to state to the Lord Advocate, in reply to a circular addressed by his lordship to the parochial clergy of Scotland some months ago, which I take leave here, substantially to transcribe.

"The only remarks I would add on the subject of the above inquiries are—that my own conviction, after a series of experiments for the last twelve years, leads me to believe—that the gradual deterioration which has been going on for some time in the quality as well as quantity of the potato crop, has in a great measure been occasioned by the introduction, to so large an extent, of animal manures—and when the plant has thus become soft and weakly, cutting it for seed, a practice altogether unnatural, and I *can say* is often attended with the worst results. When the tuber is healthy and the ground dry, cuttings will do very well, but otherwise, such a practice is almost certain to effect a failure, at least, to a very considerable extent.

"In Orkney, where almost entire parishes are in the hands of small farmers, and where manure is almost never used for potatoes, according to their ordinary rotations—both the quality and quantity of their crops are good—and any failure to a serious extent there, has, I am informed, shown itself only on those lands where a different course has been pursued, or weakly plants set. In Shetland, it is true, we have whole parishes also in the hands of small farmers, but they generally set apart a very considerable portion of manure for their potatoes; and, besides, they plant them all with the spade, and, with few exceptions, insist on making their rows run along the slope; so that every shower of rain that falls is kept standing round the root of the plant. On the whole, as far as my experience goes, I feel no hesitation in saying, that I believe *thorough draining, planting the potatoes whole* of a moderate size, and in a soil not rendered exceedingly rich for the production of other crops, would in a year or two cause disease and deficiency altogether to dissappear.

"The potato is a substance chemically different from the other fruits which it is certainly most essential to cultivate, which may easily account for what I believe to be a fact, viz., that manures, and the manner in which they are applied to the soil, while they cause the one to produce very large returns, cause the other to pine away and die."

If these ideas are at all correct, it would certainly be supplying a great desideratum if any means could be devised by which the farmer could pursue his ordinary rotation, without either injury to the produce or quality of the potato crop; in short, if any thing could be found by which the deleterious effects of those manures in general used for the raising of grain, turnips, &c. could be rendered less injurious to the potato. With a view to this important result I am trying an experiment this year, which I think will be found to answer the object, so very simple in its application, and in itself so calculated to improve, rather than injure most soils, that it seems at any rate worth a trial. What I propose is merely to fill the drills, on the top of the manure generally used (farm-yard manure) with plain sand. on which the seed, a small uncut potato, and not less than a pigeon's egg, is to be laid and covered in the usual manner. I am not quite sure of the result when the sand is laid on the top of the manure; but that it will be found to be favourable without manure, even though the ground should be in a high state of cultivation, I have had ample evidence to prove.

Much, I believe, has been both said and written for the purpose of proving that moisture has not been the originating cause of the disease; an idea in which I am disposed to acquiesce, though I believe, if there exists, from the injudicious use of manures or otherwise, the slightest predisposition to disease, the surest methods of developing such, are to neglect to dry the land sufficiently by draining,

and to keep the potatoes, after they have been taken up, in a place where any moisture is likely to gain admission.

PERTHSHIRE.

No. 105.—Mr Archibald Gorrie. Annat Cottage, Errol, 4th March 1846.

Accounts having reached us of the disease having in the month of August affected potatoes in the warmer countries on the continent, and gradually extended northward in our island, general attention was at the time directed to the symptomatic appearances of the disease, on commencing in the foliage, and extending downwards to the tubers; and those symptoms appeared in the low Carse of Gowrie, on rich lands, where the stems were luxuriant, about the middle of September. On the braes of the Carse, on dry black lands, the symptoms of the disease were less apparent, and there, ultimately the malady was less severe.

It will be recollected, that in the end of August, and the two first weeks of September, the weather and soil were tolerably dry. My attention was at that time particularly directed to a field under potatoes in Annat park, braes of the Carse, about 50 feet above the level of the sea, on strong black loam.

In that field I had the most part planted with the Perthshire reds in the end of April, and dunged in the drill with well rotted farm-yard manure. About a quarter of an acre was planted with a purple kidney recently from the wilds of Peru, at the same time with the Perthshire reds.

It occurred to me, from the accounts reaching from the south, that excessive moisture during the period when the tuber had obtained its full size, and before it was properly formed or ripened, had been in a great measure the means of producing or extending the disease. The stems of the Perthshire reds having before the middle of September shown a healthy-coloured ripening foliage, free from spots, while on neighbouring fields the stem and foliage continued green, induced the hope that my potatoes might escape, and certainly, as compared with those in the low Carse, there was little cause for complaint; but on turning, and examining and picking a month after they were in the pit, a sixth part was found diseased; and this was quite observable at taking-up time, about the middle of October, as the disease had commenced soon after the rains on the 14th September. The Perthshire reds, it is well known, have been long in a deteriorating state, and never show that smooth glossy leaf, vigour of stem, abundance of blossom, and profusion of seed plums, as about 38 years ago on their first introduction into Perthshire; but the new Peruvian kidney, possessed all that healthful vigour, and the foliage, blossom, and abundance of seed plums indicated youthful vigour. When the heavy rains commenced on the 14th September, I fondly hoped, from their vigorous appearance and the ripened state of the seed-plums, that I had obtained a variety, which, besides its excellence, was likely to escape the common disease, and at all events to produce a healthy stock from which to raise seedlings from the plums, a parcel of which I collected and prepared for the purpose of sowing; and a small parcel of which I take the liberty to enclose, in the hope that some of your correspondents will join me in giving it a trial; and in the confidence that a healthy plant will be raised from a vigorous parent, for the seed-tubers were collected before the disease appeared in the tuber; but on the 20th September the disease began to appear, and the ground was so wet that they could not be taken up before the 14th October, when nearly one-half seemed diseased,—showing clearly that the *quality of the potato*, perhaps its excess of starch, renders it more liable to the disease, than the coarse variety of the Perthshire reds,—the Peruvian kidney being the very best potato I had ever tasted. To test whether potatoes are liable to infection, I tied a number of diseased potatoes to sound ones, some I cut, and joined the healthy to the diseased part of another's tuber, also cut; part of these I covered four inches in the ground, and part I inserted in the middle of a potato pit, the ground indicating 43 degrees

Fahrenheit, but the pit, as is generally the case, indicating 15 degrees more. I found that this elevated temperature produced a rapid extension of the disease, the cut sets showing the exact impression the diseased parts had made on those with which they were made to come in contact, and in a week penetrated an eighth part of an inch in the formerly sound tubers. Those in the ground remained uninfected at the end of a month. The disease made rapid progress amongst my favourite variety, and by the end of January not one sound potato remained in the pit. I may mention, that having raised it for several years, it never before was in the slightest degree tainted; and I may also mention, that in the same field were a few of the Yorkshire reds, later than the rest in planting, not in the least tainted.

An alarm has lately been spreading, that diseased tubers are likely to produce a diseased stock, if used as seed; I have some reason not to be apprehensive of this, for in May last I planted all my varieties, on newly reclaimed hill-ground 600 feet above the sea; the Perthshire reds and a variety called buffs were from pits partially tainted, and many of the sets being the fresh parts of the diseased tubers; and on nearly an acre I have not been able to find a single diseased potato. I do not attribute this so much to the new or fresh state of the soil, as to its dry heath-mouldlike nature, and the absence of farm-yard manure, which, when producing over luxuriance, has been found hurtful. The ground was manured with about three cwt. Ichaboe guano. From this field the Peruvian kidney is quite free from taint as well as the other varities. Although I have stated this fact regarding my success from tubers not quite sound, I, as well as others, will prefer healthy seed tubers when they can be obtained.

No. 106.—Mr W. Ewing, Strageath, Crieff. February 11, 1846.

That the disease was caused by "atmospheric influence," there can be little doubt. Much has been written and said with regard to the cause; minute fungi having been found in the decaying potato, the source of disease was attributed to them. That parasitical fungi, similar in their nature to those which produce mildew and dry rot, were the real cause of the malady, is the general opinion of those whose extensive knowledge entitles them to respect. It has been stated that one of those plants belongs to the genus Botrytis, and is described as entering by the breathing pores of the potato leaves; passing down through the interior of the stem into the tuber, where its spawn fixes itself, traversing the cellular mass, separating the cells, causing alteration in their chemical condition, and thus producing decay. In other cases, in diseased portions of the potatoes where the spawn is not apparently distinguishable by the most practised observers, it is suggested that the juices of the plant may be vitiated by the parasite which destroyed the leaves, and that particles too obscure to be distinguished by the eye might be circulated with the juices, producing disease by irritation. Without the aid of the microscope, the presence of the parasite is not to be detected, unless it make its appearance outside the potato in the form of mouldy tufts; hence it is inferred that it is produced exclusively from within. The evidence of the best microscopical observers is conclusive on the point, that, in diseased potatoes, the spawn of fungi is found in large quantity: and it is well ascertained that these parasites spread rapidly in warm and damp situations, producing infinite mischief, which is to be successfully resisted by dryness and a low temperature.

But the mildew-fungial theory does not appear to have been well established, for it is difficult to conceive, why fields of potatoes near each other, and even the same kind of potatoes in juxtaposition in the same field, should be differently affected, and certain varieties more injured than others. And how it is that when sound potatoes are heaped where diseased ones may chance to be amongst them, that if mouldiness appears, it rapidly establishes itself on the sound potatoes, especially if the temperature of the pit is high, and will rapidly extend throughout the entire mass.

Peculiar weather was observed over the whole of the north of Europe, as well as in America, where the disease had declared itself. About the middle of June 1845, we had a few hot days followed by cold, and after the beginning of July, the weather again became suddenly hot, which as abruptly changed into cold; continuing throughout the end of July and greater part of August, with a great want of sunlight along with the rain and low temperature that prevailed. Such a combination of untoward circumstances would appear ill-suited for the healthy growth of the potato—a plant absorbing a large quantity of water, its whole

construction being formed with a view to its so doing; and to enable it to part with this water its broad succulent leaves are provided. To the motion of the fluids, low temperature is unfavourable, or to the action of the cells of the plant; and to enable the water sent into the leaves to be perspired, sunlight is moreover required. The amount of perspiration of a plant in feeble light is small—in bright sunshine, copious. All these important functions were deranged during the last season. That the potatoes have been compelled to absorb an unusual quantity of water, and prevented digesting it, by the lowness of temperature and want of sunlight rendering it impossible for them to get rid of it by perspiration, has been ascertained by analysis of sound and diseased potatoes. The sound ones of previous years were found, by that eminent chemist Dr Lyon Playfair, to contain on an average 72 per cent of water, but last year from 72 to 75 per cent; whilst the diseased potatoes yielded as much as 80 per cent. This must necessarily have stagnated in their interior, producing irritation and vitiation along the circulating medium, thereby causing a consumption in the potato, arising from the decay of its particles by the state of the cellular tissue, brought on by the weather. The disease is believed to have arisen from physical or chemical causes produced by the decay of the potato tissue, in unison with the oxygen of the atmosphere.

Although the first symptoms of disease appeared to commence in the leaf, spotting and corrugating it as it spread, yet it is believed by the best *practical* observers to have commenced underground, in that part of the haulm immediately above the old set.

From the prevalence of high winds, the potato haulm was knocked about until it had wrought a hole round itself, by which the water descended, and there coming in contact with the old set that still retained hold of the living plant, and acting like a sponge—itself decaying—fed the living stem with semiputrid matter. Sudden warmth had forced into preternatural vigour the potato plant, and debilitated its organisation. A low temperature as abruptly succeeded, with frost, enervating the whole plant, and especially affecting that tender part of the haulm just under ground, where water collects most, and the temperature is lowest. The spots on the leaves were merely the symptoms of the underground malady; for when the attack on the stem beneath the ground was slight, no indication of its presence was traceable in the foliage.

Potatoes have suffered most on deep loamy and clayey lands, and less in dry, elevated, sandy districts, where the influence of the season was mitigated by the slowness of growth, or compensated for by the natural warmth of the soil. Peaty soils suffered least, and those on the purest moss were decidedly soundest.

The cells of the potato are found to be composed of nitrogenous or azotised substances, such as vegetable albumen, &c. Moss being largely composed of organic matter, sometimes as much as 70 per cent of its whole weight—when brought into a favourable state for decomposition, by the destruction of its antiseptic or preserving quality, must furnish in great abundance protein compounds so necessary for the proper framework of the potato. Animal and vegetable matter added in abundance—which is commonly the case for a potato crop—will likewise, in a peaty soil under decay producing ammonia, add greatly to that important ingredient—and ammonia is found to promote vegetation in a remarkable degree. The cellular tissue of the tuber being strongly formed, was in a favourable state for resisting the vicissitudes of the late season—and not to be easily ruptured. If the framework of the potato be not strongly formed by having a due supply of nitrogenized matter, the cells, becoming surcharged with starch, will naturally be broken, and injure the cellular structure, rendering it more liable to decay under circumstances such as heat and moisture.

Rank ill-made manure taken from the court-yard, soaking with urine rich in ammonia, and applied to alluvial soils, without at the same time being properly balanced with a proportion of carbonaceous matter, will necessarily produce a waxy or hard-hearted potato, from an over-abundance of protein compounds, producing cells without starch to fill them; but at the same time will produce a vigorous foliage, enabling the plant in course of time to obtain carbonic acid from the atmosphere, to form starch, as well as from the decay of the manure in the soil—supplying an overdose of carbonic acid; which carbonic acid is supposed to enter the roots, but at all events does enter by the leaves; and consequently produces a mealy outside. A rupture of the outer cells, inside the cuticle, in the above circumstances, may fairly be supposed to produce decay of the potato, eating inward like a canker. It is perfectly obvious that the manure should be properly prepared, having the due proportion of azotised substances and alkaline bases, to enable the plant to assimilate the food necessary to form its different component parts, as it cannot obtain a supply of carbonic acid from the atmosphere, till the leaves are formed.

In growing potatoes for seed, they would appear to require different treatment from those for the table, feeding cattle, and the starch manufacturer—the former to have a liberal supply of protein compound, the latter carbonaceous matter to a greater extent. Finally, according to the present state of our knowledge, as there are differences of opinion among scientific men, let us bring the soil into a fine physical, or dry clean friable state, and then add the organic and inorganic elements in sufficient quantity and in appropriate proportions—nature will do the rest.

The late-planted potatoes suffered most, but all were attacked at a certain stage of their growth, towards, or when near to maturing. Indeed, as a general rule, the potato crop was affected just in proportion to the state of ripeness it was in. Generally speaking, all varieties, in whatever soil, and however situated, whether high or low, were more or less affected; which is rather conclusive against the mildew-fungial theory, and is diametrically opposed to any previous knowledge we possess of the attack of mildew.

Fearing prolixity in these prior observations, let me endeavour to give a few practical hints as to the best method of preserving potatoes for seed during the trying months of spring. The potatoes should be carefully turned over occasionally by the hand, and all indicating the least disease removed. Keeping them dry and cool, by a proper ventilation of the pits or heaps, is of vital importance. A well-drained or naturally dry spot should be selected for pitting the potatoes—in narrow pits containing about seven cwt. to the yard in length—with drain-tiles or pipes placed longitudinally and transversely, at short intervals, in the bottom of the pit, with upright shafts, all open at their extremities, to give the whole a free current of cold dry air. Thatching the pits well with straw has been found to answer well, but is not sufficient to protect the potatoes against frost winds; and therefore, a very little earth must be added, with merely as much straw as will keep the earth from mixing with them—to facilitate the process of turning or removing when required—and to be well thatched and roped with straw or other material to keep the whole perfectly dry. Turf-sods laid next to the potatoes, and thatched over with straw or rushes, make an excellent covering for the pit or bin, but can only be procured in certain districts where there is liberty for cutting them, and the carriage not too expensive.

It has been recommended to bed the potatoes in layers of charcoal powder, charred sawdust, charred peat crushed, burned clay (charring soils is much better than burning to a reddish ash, as their absorbing and disinfecting powers are much enhanced by the presence of finely divided carbon), and dry soil mixed with burned unslaked lime, broken down to effect their better incorporation. But these are too expensive and troublesome plans to be generally adopted; though in situations where the materials can be easily procured, they might be employed to great advantage

That the potato crop of last year was so generally attacked with consumption in many districts of the United Kingdom, that seed potatoes will require to be imported, there can be no doubt. But mercantile enterprise will not be wanting to bring seed from the south of Europe.

The whole potato crop in the province of Gallicia in the north of Spain was reported to be perfectly sound, and as great numbers are annually grown for exportation to the Spanish West Indian Islands, a considerable quantity could be readily procured. Considering the climate of Gallicia, seed from that quarter would appear well adapted for renewing our crops. No disease appeared in the island of Corsica, which might furnish a few. Around Bordeaux, the early potatoes gathered in July were sound, although the late crop was diseased. They were reported, moreover, to be sound in the north of Scotland.

The charred packing-stuffs recommended above, should be used in storing the potatoes in the ship's hold, to prevent fermentation during their transport; for, to prevent intestine motion in the potato before it is committed to the soil, is of vital importance.

Potato planting in autumn has been practised successfully by Mr Grey of Dilston, Northumberland. He had an increase of one-third in his October planted potatoes over his April; there was little difference, however, in his October, November, and December plantings. The planting may even be extended into January—and a considerable breadth has been planted in this neighbourhood during January, especially by Mr Faichney, Kirkton and Dalpatrick—an enterprising farmer—which gives wide scope for the operation; but the land must be *thoroughly drained* or naturally dry, *deep wrought*, and well pulverised, before there is much chance of success, and the planting never attempted but when the soil is in a fine surface condition or tid. The seed also must be perfectly sound. Mr Grey's treatment of his autumn and spring planting were as near as possible alike, being placed in drills thirty inches wide, and six inches deep, with the manure under the sets, and there was no disease perceptible at the time of taking up, about the 14th of October last; the earliest, or

autumn and winter planted, showed a few blanks in the rows, but more vigour and greater strength in the stems. He had the large potatoes cut in two, and the small ones planted whole in autumn, but the cut ones gave considerably the largest crop. The spring planted had the like seed cut in two, but were defective by about one-third, which is a large deficiency when the soil and treatment were alike. The autumn planting certainly deserves a general trial after such favourable results; but in a soil that expands and contracts with frost and thaw, of course it will not succeed. There is no doubt, however, of success, if the soil be first *dried completely*, *loosened deeply*, and well *commingled*; which should be the case at all times before the potato is committed to it.

The potato is an *exotic* and *tropical* plant, and although it has long been acclimatized, we know in *practice* it is a delicate esculent, requiring a great deal more care in its cultivation and preservation generally than it has yet received.

I recommend early planting before the end of April, not only as a great preventive against failure in the seed or sets, but also in diminishing the attack of the late malady—taking into account soil and situation. I likewise advise making only two sets of a potato; to cut off the root-end, laying it aside, and to split the remainder longitudinally, so as to have some of the rose and eyes in each set, which is important.

It has been recommended that potatoes intended for seed should be planted on the flat ground two inches deep, not earthed up, but the soil kept loose and clean: and the crop will be as large, and the germinating powers invigorated by the greater number of the tubers having grown above ground receiving the advantage of light and air—strengthening the buds or eyes—and believed to be much hardier, and not so easily injured by rain or frost as those grown in the usual way. A manure containing a preponderance of protein compounds should be added to the soil some time previous, properly incorporated, and the land brought to a fine friable state, before the potatoes intended to be grown for seed are planted in the flat surface.

The wearing-out-plant theory is not well established; although no inconsiderable quantity of learning is brought to bear on that point, the varieties are dying of old age, and it is attempted to fit this speculation to the potato. But such a theory has arisen greatly, if not altogether, from deterioration in the plant produced by bad management. Raising potatoes from the seed or apples, however, is said to have driven away the *curl* in some parts of the country forty-five years ago, and for the sake of experiment, being of importance, I quite coincide with the propriety of a vigorous trial being made by the horticulturist, as being most in his province, to raise from the healthiest seed that can be procured good varieties, notwithstanding that the potato raised from seed in this part of the country only a few years ago, as well as in other parts, has equally failed with the long-cultivated varieties, from all accounts I can learn.

To imitate nature as far as *practicable* in raising potatoes for seed, is of vital importance; and planting shallow on the flat surface would appear to comprehend this principle.

No. 107.—Mr James Cousin, Overseer at Ardoch. 26th March 1846.

1st, The summer of 1845 was very favourable for the cultivation of potatoes, till the latter end of July and first week of August, with two frosty nights about the 10th August; and about the end of August the stems and leaves of the potatoes appeared ripe. At that time I cut a few stems of ours, which were very decomposed; and on examining the potato field the second week in September, I observed an occasional tuber with slight blights, as if occasioned by a stroke from a lead drop.

2d, The varieties cultivated in the district are calicoes, Perth reds, buffs, and blues, all of which are more or less tainted with the disease; those least injured are the calicoes; and I think there will be a sufficiency of that variety sound for seed to plant the district, and on most farms they have suffered comparatively little, particularly on the farms that have a northern exposure; and at this time those free of disease are shooting strong healthy stems. The reds, blues, and buffs, have been very much affected, and few of these varieties will be fit for seed; in fact, they decomposed so fast, shortly after being stored, that they have mostly been consumed by cattle, or carted to the potato mill. I cannot distinguish much difference from those long grown and the ones lately raised from seed, but think those recently obtained from seed have the preference. I find potatoes grown close by the side of the Allan, where the ground is loamy and damp, and those grown on higher and dry ground, are very little different, particularly if the seeds have been previously planted in the same soil; but seed taken from dry land to damp, or from damp to dry, the

crop has been more diseased; but there is little or no disease in mossy land, and in land that has not been cultivated previous to the last potato crop. I do not think the different kinds of manures influence the disease, as I have seen evidences in the same soil of long stable-yard dung, and a half manuring with well made dung and half guano, without being able to distinguish any difference as to the disease in the crop.

3d, The mode that has been adopted in storing the potatoes is laying them in heaps about a yard wide, upon round sticks or sleepers laid over with a thin turf, and an open drain, cut 18 inches wide and 16 deep, round the pit, and the pit covered with straw, and in some cases with earth, ventilating the top of the pit with small bundles of straw, which are removed and replaced at pleasure; but I find an entire covering of straw has answered best. I have tried mixing the potatoes with lime when pitting, but without any benefit; and I think the very best plan that has been adopted for preserving the crop is, that in allowing the potatoes to remain in the drill where they were grown, covered over with earth. I have examined several fields left in this way, and the potatoes that were not diseased at the end of October, are in most cases free of the disease at this time. I admit, by allowing the potatoes to remain all winter in the drill, I lose all those diseased; but should the disease appear again this year, I shall turn over the potato drills about the 1st November, remove all that I think diseased, and cover up those apparently sound; for in my opinion the potatoes have got delicate, and liable to injury from changes in the atmosphere, and perhaps letting them lie all winter in the bed they have grown, will renew their constitution.

The cupsees have been longest cultivated in this district; there have been very few reds planted for the last two years, and they are less diseased than the buffs and blues; it is only about ten years since the buffs were first generally cultivated here.

No. 108.—Sir JOHN S. RICHARDSON, Bart. of Pitfour. 4th May 1846.

Query 1. About the end of August I discovered the first symptoms of disease, in the form of an occasional dead stem and leaves. There had been much rain and a low temperature, and the stems were unusually luxuriant. On examining the tubers at this period I could discover nothing wrong, and I kept some of them for a couple of months, which continued sound even after being cut in halves. I observed nothing peculiar about the flowers, and the apples were generally well ripened, which I have proved by raising a large quantity of young plants from the seed. It was the beginning of October, before the fields in this neighbourhood were discovered to be generally affected, and at this period the brown gangrene under the skin was perceived. This gangrene was the general character of the disease in this part of the country, and there was very little of the internal rot which was pointed out to me at the Dumfries meeting, as the characteristic feature of the disease in that locality. In the month of October the stems became soft, fell down and then blackened. In August the black stems remained standing, and the same may be said of September.

Query 2d. I understand that the regents escaped the disease on a farm in this neighbourhood, but this may be accounted for from the circumstances of the case, viz., a mossy subsoil in many parts of the farm. As far as I have learned, potatoes recently obtained from seed shared the same fate as old tubers.

The excessive moisture appeared to me to have aggravated, if it did not cause, the disease. I am not aware that either previous cultivation or the kinds of manures had any influence in promoting, retarding, or preventing the disease.

In light, and especially gravelly and mossy soils, there is scarcely a bad potato, whereas in strong and retentive soils a sound tuber is the exception. In the latter, even although drained, the soil was saturated with moisture for a very long period, while in the former the excess was rapidly carried off. In the latter, the stems were rank, and probably contained a superabundance of deleterious sap, which found its way to the tuber, while in the former the stems were not more luxuriant than they usually are in strong soils.

In the month of August I saw a field of potatoes in the uplands of the district of Athol, of which the stems and leaves were then quite yellow and almost dead, and yet there is not an unsound potato from the field.

Query 3d. Potatoes have been stored with ventilators of tiles, some merely covered with straw, others with turf, others in the ordinary way, but there appeared to be very little difference in their eventual decay. Even at this date, in the midst of a rotten mass of tubers, occasionally potatoes perfectly sound are picked out.

When I first suspected that the disease had reached my fields, I proposed pulling all the stems of my potatoes, but I was dissuaded from doing so by the opinion of two agriculturists of more experience than myself. Several weeks afterwards I did so in one field, and had them mown over in another. Both fields were very wet when the potatoes were taken up, and immediately shipped on board a vessel for the London market, where they arrived after a fortnight's passage, with the greater part of the cargo in bad order; but some that were gathered from the field where the *stems were drawn* are the only sound potatoes which I now have. I found nearly the same result in a cottager's garden, where all his potatoes were diseased, except those in one division, of which the stems had been cut over with the sickle for food to the cow. If the disease appears again, I shall be much disposed to try the effect of this treatment in the fields. I am now doing so in the garden forcing-frames, where the disease has shown itself, just about the time that the ripening of the tubers commences.

I have omitted to mention that I tried the effect of kiln-drying, which produced a blackness, and, in some cases, a hollow portion in the centre of the potato; thus, I think, proving that a portion of the potato was not thoroughly ripened, and indeed this was in most cases very evident if a thin skin were cut, when you found the interior unusually transparent, with an excess of moisture sufficient in many instances to trickle over the side, and the starch cells rough and ill formed.

The potatoes turned up by the plough for spring wheat, *in wet rich land*, were not more unsound in the month of February than those which were pitted in the months of October and November, while the same treatment appears to have caused decay in other cases. With those who left the potatoes in the drills during the winter, I find they have kept well in dry ground alone.

I planted in January, February, and March, all in strong rich land, and the tubers appear generally sound and sprouting vigorously, while I learn in other parts of the country that the early planted seed has rotted. Mine, both whole and cut, were powdered with lime.

No. 109.—Sir David Dundas, Bart. of Dunira. 28th May 1846.

In answer to *query first*, it would be about the 20th September that the shaws first appeared to decay, the weather being wet at the time. The stems at first looked brown, as if scorched, and afterwards they naturally died away.

Query 2d. The common white garden potato entirely escaped the disease; this might arise from their being earlier ripe than the other sorts. The Perthshire red has been much less affected than have the kinds called calico, buff, and blue. From my own observation, I have found no difference between the potatoes raised from seed, and those from the original tubers. In this locality, potatoes planted in moss land have been less affected than those in black or tilly soils. The different kinds of manure seem to have had no effect in promoting or preventing the disease.

Query 3d. In general they have been stored in the usual way, in pits, these being much smaller than in former years. A good many have covered them with thin turf under the earth, some covering them as usual with straw, others with fern. The former of these is generally admitted to have been the best, but I believe the most successful way has been in spreading them thinly over a dry clay floor, such as a malt barn. This has been found a very convenient way, as they have required to be so many times picked, that this has been found to be the only proper way to prevent the diseased potatoes from infecting the others. Wooden floors were tried, but proved worse than either pits or clay floors.

The field in which potatoes were planted in 1845, was recovered from muir in the winter of 1843-4, having been about fully half drained on the furrow system, oats having been in part of the ground in 1844—elevation about 400 feet above the sea level, and having a southern exposure. After having got two furrows, the potatoes were planted in the beginning of May (from the 5th to 9th), the weather being cold and damp at the time. There were used about thirty tons of well rotted farm-yard dung per acre, and planted all with Perthshire reds, except a few drills of calicoes, the sets being pretty large. They came away strong and healthy, and continued so until the middle of September, after which they made little progress, until the shaws naturally died away about the end of that month. They were allowed to remain in the ground until the 27th October, when they were lifted and put in very small pits, and covered with turf, in which way they remained for a fortnight without any earth. Being then naturally dry, they were covered with about six inches of earth, previous to which a part of one of the pits was carefully powdered with

hot lime. There were a few of the sort called calico in a small pit by themselves. At the time of lifting, the disease appeared amongst these, but the reds seemed almost entirely free from taint. On the 19th of November, the pits were opened; the reds were in fine order, and looked equally as fresh as when they were put in; the calicoes were decaying, and covered over with white spots. On the 10th of December, the reds looked well, and were good for using, although not so floury as in some seasons, but this might be accounted for on account of the new land and heavy crop. On the 2d of January we again looked over the pits, and found very little alteration on the reds, but previous to this the calicoes were so far decayed, that they were only fit to be given to the pigs. On the 28th of the same month, little could have been said regarding any change, but on the 24th February, on looking them over, there were some white spots discoverable upon them, but not what might have been thought any thing material. On looking them over on the 12th March, the spots had much increased, and decay seemed to be evident in about a fifth or sixth part; the others were growing, and some of them had sprouted half an inch; they were then carefully hand-picked, three-fourths of the whole having been found quite fresh. We are still continuing to hand-pick them, the disease continuing, but not making rapid progress. There was no visible difference between those limed and those not.

PEEBLES-SHIRE.

No. 110.—Mr Andrew Buchan, Factor at Haysteune. 14th April 1846.

I may first state I have seen a little disease among our potatoes here for three years past, but rather more this year than either of the other two, and still to no extent worth notice.

Crop 1844 I planted as I always do, one half blue, the other half of buff potatoes: the blue were on the low side of the field, which was soft mossy soil, originally drained from a marsh: the buffs were on the rising ground alongside; part of the ends of the drills, however, entered forty or fifty yards into the marsh. The blues were as fine a crop as ever I lifted, the shaw strong, bloomed full, and carried immense quantity of seed; in the buffs the shaw came up tender, never covered the ground so well, nor bloomed so full, and carried seed but partially; and although the shaw was stronger on the marshy ground, they were not equal to the blue. I paid no further attention to them till lifted, when the buffs were smaller, and quite an inferior crop to the blue. I pitted them out in a dry field-pit, sunk four inches into the ground, about $3\frac{1}{2}$ feet wide, covered with straw, the whole covered with earth eight inches thick, with a wisp of straw protruding through the top of the pit as a ventilator at every fifth cart-load. When the pits were opened, I found a number of rotten ones among them, but not to a great extent. I observed a white moulding round the eyes of some of them: when these lay a short time longer, they uniformly became rotten; and I also observed, that none of those upon which the mould appeared ever sprang; the eyes appeared to be entirely dead.

I planted a part of the blue over again in 1845, but purchased new seed of the buffs from a higher district (neighbourhood of West Linton.) The crop upon the whole nothing like to 1844, but the blues were as much inferior to the buffs this year as they were superior last. I manured part of the land upon which they were planted in November, and part when planted, with farm-yard dung; those manured when planted came fully quicker up at first; but when taken up I knew no difference in them, neither did I observe any difference of the disease in those manured in November, from those manured when planted. A part of the land at the head of the field was heavy clay damp land. I observed the disease was worse here than elsewhere on the field; but the worst of all was upon a sandy dry knoll in the very centre of the field, where there were double the quantity of diseased ones that were in the wet part, although there were more in the wet part than in the rest of the field. I paid no particular attention to them in the early part of the season.

When taken up, and seeing the disease fairly upon them, I laid them all upon the ground-floor of a granary, floored with wood, with windows for ventilation on all sides, which I kept frequently open; picked them all over, took out the small and those seen to be diseased, laid straw between them and the walls, but nothing on the top, till the appearance of frost, when I covered them with straw, which I immediately removed on the return of

fresh weather. I frequently looked at them during winter, but never considered it necessary to turn them over again till about the end of February or beginning of March, when a few more diseased ones were taken out, but not worth mentioning, perhaps 1-40th or 1-50th part. For a number of years past, I have observed partial failures from the sets dying. I have been in the regular practice of planting all my middling-sized small ones whole, and find them never to give way; they require to be planted thinner than those cut, as more stems come up from them. Those planted of whole potatoes had as much disease among them as the cut had. I may mention, that I observed it recommended in a newspaper to dry the potatoes slightly upon a kiln. I tried this also, but found them to do much better in the granary. In short, I found the kiln a complete failure as a preservative, as they went further wrong than the others. I have made no trial of any way of keeping them but one; but having the means, I adopted this as the most likely in my estimation to keep them. Although I did not make the trial of a pit this year, it is my belief, had I closed them up in a pit, they would have been worse than they are

No. 111.—Mr Robert Boyd. Marmion Place, Innerleithen, 16th March 1846.

The disease made its appearance here about the 15th of September last, and for some days previous to that date, the soil was completely saturated with rain; and being succeeded by two or three days of excessive heat, at mid-day the steam or vapour was distinctly seen rising from the soil, and to this cause we attribute the premature decay of their stems, which had more of an *autumnal hue* than the *blackened* appearance of shaws which had been cut down by frost. No sooner did we discover the premature decay of the stems, than we instantly examined the tubers below; and although assisted by a microscope of considerable power, it was not until eight or ten days had elapsed that we could discover the slightest taint, which had a brownish appearance, somewhat resembling a rotten apple. The shaws, which had decayed most rapidly, were almost in every instance found upon examination, that the epidermis of the stalk below the surface of the ground was of a *mouldy* appearance, and more or less in a state of decay, often disintegrated and completely rotten; the leaves and branches according with the state of the part of the stalk below the ground. That certain varieties have so far escaped the disease as to show that the predisposition was stronger in some than in others, will be questioned by few. Some years ago, we got a few seed potatoes from Mr Bruce, tenant, Greenknow, Berwick—they are known by the name of "Jacob's cattle"—which had been planted by Mr Bruce and his father during the last eighty years without one solitary instance of failure; and with ourselves last year, the crop was most satisfactory, and perfectly free of disease. We planted last year, by way of experiment, six rows of black potatoes, which were gathered from the tops of the drills, and were green-sided on account of their being uncovered and exposed to the sun. We also planted other six drills, which were taken from the same *stems* that produced the green-sided ones alluded to: but while the former produced an excellent and a perfectly sound crop, the latter turned out a miserable one, and any thing but free of disease. The late green-nibbed kidney we found a healthy variety, having produced large bunches of apples, and their stems continued healthy and vigorous until cut down by the frost, and up to this moment not a solitary tuber has fallen a sacrifice to disease. Last season we examined a ten-acre field of potatoes, the greater proportion of them being the property of the cottagers of the village of Innerleithen. Seed potatoes, we are aware, were brought from almost every quarter of Scotland; the variety of manures, too, were great, being every kind in use, from the scrapings of the roads to the refuse of the woollen manufactories, which is composed of wool and oil, the strongest manure that is used. Notwithstanding, the disease pervaded the whole field, with the exception of a small quantity which had been planted with seed brought by a gentleman some years ago from South America, and a few of the old Scotch whites, and the old Scotch black. The cups, although hitherto but little used in the county for seed, so far as we can learn, have altogether escaped the disease.

From repeated experiments performed during the last five years, we have found that the old and long-cultivated varieties have been less subject to failure than the new varieties raised from the apple. In point of fact, until such time as we began to raise new varieties from the apple, such a thing as failure or disease was never once heard of, and to this circumstance we in no small measure attribute the deterioration of the common or late potato. We are prepared to name many of the shepherds of Scotland who are about to plant seed potatoes of different varieties, which have been handed down from father to son for some generations past, and who have never up to this moment observed the slightest

taint or disease, or anything in the least degree approaching to a failure, although they have been planted upon the identical spot of ground for 30, and some of them for upwards of 40 years, and manured annually at the rate of 50 tons an acre. In the ten-acre field already alluded to, where the disease prevailed so universally, various patches of early potatoes were planted of different varieties, which were found at lifting to be perfectly free of any taint whatever. Had the mode of raising new varieties of the early potato been equally simple as that of raising the late, we have no doubt whatever but the early potatoes would at this moment have been in no degree less tainted than many of the late varieties. Last year, Mr Thorburn, tenant of Elibank, planted a small field on the bank of the Tweed, of 3 or 4 acres, the shaws of which were entirely consumed by the rabbits long before they were ripe; and although the crop (which was extremely small in size) did not amount to a fifth part of an average, and altogether unfit for the table, they are considered well adapted for seed, being perfectly sound.

Mr Brydon, Haugh-head, planted last season with potatoes a bank of so precipitous a nature, that it stands about the angle of 45 degrees. The crop was not very abundant, but excellent in quality, and perfectly sound in constitution, while those planted on the horizontal plain at the foot of the bank, were tainted to a potato. Mr Dalgleish, overseer to Mr Ballantyne of Hollylee, on lifting the potatoes last year, found that the buffs were much infected with the disease, while the cups were perfectly sound; and, by way of experiment, half a boll of each kind were regularly mixed together, and piled up in a heap, and carefully covered over with farns; and after allowing them to remain in that condition for nearly a month, the pit was uncovered, and after the most careful examination it was found that no injury whatever had been communicated to the cups, although the taint in the buffs had been gradually increasing. The late Tam Tait, the minister's man, who had been regularly trained to the cultivation of the soil from his earliest infancy, and who was a great enthusiast in propagating the potato, and who, for many years previous to his death, made a regular practice of collecting the excrescence or plums produced by the potato stems, which he kept in a cask of sand during the winter for the following year's seed. We have often witnessed in the same field, when a great number of the cottagers' potatoes turned out all but a failure, Tam's invariably continued healthy and vigorous, and there is no instance on record of his having ever experienced a failure. From the experience we have had ourselves of this description of seed, we without hesitation pronounce that of all methods for renovating the potato plant, the planting of the *plums* is decidedly the best, and any quantity can be produced by simply breaking a portion of the stems; indeed they can be produced from no other cause. With regard to the storing of potatoes, we should say from experience that keeping them in a large well-ventilated apartment is unquestionably the best and most economical mode of preserving this valuable root—affording as it does a daily opportunity of turning them over, and at same time selecting those that are tainted for the cattle and the pigs. The next best method which we have proved from experiment, is pitting them with dry sawdust, allowing, if we may so speak, every potato to occupy its own cell; and although some of them should turn out tainted, we find that it does not communicate any injury to its healthy neighbours. This method we find superior to pitting them in the soil, as the sawdust seems in some measure to arrest the disease, or at all events it does not hasten the decomposition of the plant so rapidly as the moist earth; but in the keeping of *sound* potatoes for seed, we give a preference to their being kept in the soil to every other method hitherto known. The early planting of *cut* potatoes is, in our opinion, one of the greatest errors which can be committed in the management of this valuable root—having ourselves more than once found from experience, that potatoes planted early in April turned out a failure; while the same seed, planted in the same field with the same manure early in May, turned out a most satisfactory crop. When potatoes are planted whole, they cannot be too early put into the ground, provided the soil is in a condition to receive them, as they can nowhere be in a state of greater preservation than in the soil. From the early nature of the present season, which certainly forms an exception to the general rule when potatoes ought to be planted, and we would therefore strongly recommend that all potatoes be planted nearly a month earlier than usual, otherwise a large proportion of the *sprouts* will be destroyed or broken off in the planting, which will have the effect of deteriorating the plant most materially. Seed potatoes this year, from which the sprouts have been plucked off, ought to be regarded with suspicion, and rejected in every instance when known, as it would be imprudent in the extreme to plant potatoes for seed, which have already exhausted more than one-half of their vital energies.

At a late meeting of the Agricultural Chemistry Association, we observe that Professor Johnston showed a potato which he said was a perfect mass of disease, and yet bore a healthy and vigorous shoot, which showed that a diseased potato would grow, while Dr Greville stated that the tubers which it produced would not necessarily be diseased. This was a consolatory assurance, and ought to be widely known. The learned professor also recommended "the propriety of planting potatoes before they *began* to shoot." With regard to the planting of diseased potatoes, we can speak from the result of repeated experiments performed during the last three years, during which we not unfrequently removed the soil from around the seed plants, so as to ascertain the true cause of their failure, which we attributed to the rapid decomposition of the cut or whole potato, as we all but invariably found that although the upper extremity of the sprouts was strong and somewhat healthy, yet they diminished so rapidly in size until they reached the old tuber from whence they took their rise, and at that point were found upon examination to be so extremely delicate, that they much more resembled a fine white silk thread than potato sprouts. The fibres or roots, too, were in general so delicate and so imperfectly formed, that in some instances they were scarcely perceptible, and therefore we ceased to wonder why so large a proportion of them never came to maturity; and when any of them reached that length, they were not only highly unproductive, but the tubers in general were small, and of the most unshapely form, not unfrequently resembling finger-and-toe turnips. From these results, we would consider it unwise to plant diseased potatoes for seed. If ever there was a time when more than ordinary exertions ought to be made in the selection of potatoes for seed, it is certainly the present; and with all due deference to the opinion of Professor Johnston, we would strongly advocate (from the diseased state of the potatoes, generally speaking) the propriety of testing the vitality of all potatoes intended for seed before planting, and this can be easily accomplished by putting them into a warm apartment, where they will sprout in the course of a few days; thereby affording an opportunity of selecting those that produce healthy, vigorous stems, and rejecting those that produce sickly sprouts, as also those that show no symptoms of vitality whatever. These methods being adopted, the probability is, that a crop of a satisfactory nature will be the result, while those planted before they have shown the slightest vitality will prove blanky and unproductive. In these opinions, we feel assured that we have the concurring testimony of every practical agriculturist who has given the subject that consideration which its importance so fully demands.

RENFREWSHIRE.

No. 112.—Mr William Glen. Hawkhead Mains, Paisley, 24th March 1846.

1st, About the beginning of September last year, the weather having been cold and damp, the stems and leaves presented the appearance of having been touched with frost, though I attribute this not to frost, but to firing, or some kind of heat in the atmosphere. The disease was very little noticed in the tubers till the beginning of October, when, after a continued cold rain of about two days, the disease showed itself in them by a brown appearance under the skin, which increased to a hard black substance, with a disagreeable odour, until decomposed altogether.

2d, I am of opinion that neither the previous cultivation nor the wetness or dryness of the soil, have had any effect upon the disease, but would say, that in very rich soils, and in places where they had been forced, or a great quantity of manure of any sort used, with the view in either case of producing a great crop, it has been decidedly worse; whereas in places where there was a poor crop, it has not been nearly so bad. Potatoes raised recently from seed, seem to have been as much affected as those raised from sets; but of the different varieties I think that the "American early," "cups," and "Irish rattlers," have been least affected, the kinds cultivated commonly in this neighbourhood, while "smooth and rough reds" were very bad.

3d, The best way to keep potatoes, I would consider to be, to put them dry in small narrow pits, with not more than 2 to 3 cwt. per yard, kept dry and well ventilated.

By adopting the above plan, the potatoes, particularly the varieties above mentioned, have kept well without there being more *rotten* ones than we have had in former seasons, though I still think that the *disease* is in them. By taking great care, however, in the selection of the sets, and with the advantage of a good dry season, I should hope that the disease will yet leave us.

No. 113.—Mr Thomas Glen. Hawkhead Mills, 26th March 1846.

I commenced planting my potatoes the first week of April 1845, and finished on the 30th.

I had a good braird, and the crop looked very well up to the 20th August, when the shaws had the appearance of being frosted, but not very bad.

I sold them on the foot on the 15th September, but reserved for family use a few bolls of the first planted ones, which were stored at that time, and have remained quite free of the disease; the rest of the crop was lifted about the beginning of November, and pitted in the usual way, viz., about three bolls in the yard, with straw and earth put over them. In about a week after which, on examining the pits, a number of the potatoes showed small mouldy spots; and in less than two weeks after this, there was a violent fermentation in different parts of the pits, and great loss.

The variety of potatoes planted was the rough red.

I had nineteen acres of potatoes, about four of which were sold by green sale, without any appearance of the disease being seen.

I may mention that I planted the head-ridges with American early potatoes; they were lifted at the same time as the principal crop, and put into small pits, intending to reserve them for seed; but I had to remove them soon after, as they were spoiling fast, to an out-house, where I mixed burnt gypsum amongst them, which had the effect of completely drying the diseased potato, and stopping any further loss.

I intend to plant three acres this season with this seed: indeed, I have it cut, and was ready to plant it on the 13th current, when the weather broke; but as the cuts are well dried with burnt gypsum, and from my experience last year of the good effects of gypsum, I have no doubt the seed will be as good for planting a month after this as it is at present.

No. 114.—Mr Peter Algie. Old Mains, Inchinnan, 31st March 1846.

The potatoes most productive, and kept the growth longest, were those that suffered most from disease; whereas those which were frosted, and decayed soon were generally free from disease. I commenced taking up for market on the 26th of July, and continued during every lawful day, without hearing the least complaint, till the 4th of October, when a slight frost and heavy rain set in; and after that date, the disease manifested itself, and made rapid progress, so that they became quite unsaleable. So I think it must have been something in the atmosphere that was the cause of the disease; but how it might have been avoided or retarded, I do not know.

No. 115.—Mr John Brock, senior. East Barns of Clyde, 4th April 1846.

I never had so large a crop, having upwards of 1200 bolls. I had about 800 bolls dug before I was afraid of the disease, and pitted them in the ordinary way, about three bolls in the yard. However, on examining the first dug pits, I found them in a great state of fermentation, and quite hot.

I made air-holes through them and turned them, mixing them with lime, &c., but to no good effect. I did not dig the others till after three weeks, and put them in small pits, about one boll in the yard, and ventilated them with drain tiles; and they kept much better, but the disease was as bad in them, and I had to sell them for making farina, to cowfeeders and others, at a low price, from 10s. to 14s. a ton. With regard to the first point, the Society wishes information regarding general appearances. The places in the field where the stem and leaves gave way first, were freest of the disease; where they kept the growth, which is considered a sign of a large crop, they were far worse, or where planted and heavy dunged with strong fermented manure, they were all bad, but a large crop. The second point with regard to the various kinds, I cannot say I know any difference, for I change all my seed every year from the Mearns, or some high ground known for raising good seed; and though my ground was all drained, they were all bad. As to the manure, I should suppose that strong fermented horse-dung was the worst, as potatoes keep the growth longer with that manure.

With regard to the third point of storing or pitting, small pits would be best, if well ventilated with drain tiles, and only well covered with straw till the frost begins to make its appearance; but should the tubers be as deeply affected as they were last year, even these expedients will not save them, though they may be the means of making them keep till applied to other uses.

No. 116.—Colonel D. H. Macdowall of Garthland, Lochwinnoch.

1st.—*July.* I first observed the plant affected partially, the stem drawn up and dwindled, leaves not expanded, the seed at root moist and decayed. *October.* Observed the new tubers affected, but not generally; a slight brown mark, like a bruise on an apple, increasing rapidly when pitted, when whole pits are destroyed in a few days.

2d. Early potatoes the *least affected;* of the late potatoes *the cups* appear the strongest plant, and least affected. Causes very contradictory and inconclusive. Wet seasons; *seed not ripe;* too early taken up; on account of frost or following crop; six months required fully to ripen. The earlier planted the smaller the crop, but the better the potato. Soils in the same field contradicting every principle—high and dry, *moss and wet*, dry manure and night-soil, alternately good and bad *crops.*

3d. Shallow dry pits, and lightly covered. Many saved by dry-housing, constant picking, and dusting with lime.

No. 117.—Mr A. F. Gardner, Overseer, Barochan, 28th April 1846.

Query 1. The disease appeared first upon this farm at the end of August and beginning of September, in a small field of American early potatoes. I may remark that this field is completely sheltered upon three sides by wood; the fourth side, or south one, is open. It next appeared in a large field upon the north side of a hill the beginning of October, although it was general in the low part of this district by the end of September. The stems, leaves, and flowers, upon the two fields mentioned above, were not in the slightest degree affected previous to the disease appearing in the tubers, nor afterwards, as the stems and leaves above ground continued quite healthy to appearance, with diseased tubers attached to them; and I have lifted what appeared decayed or ripened stems and leaves, with the tubers attached to these stems, which appeared and continued to be quite sound and healthy. When first attacked by the disease, the tubers appeared on the outside of a livid purple colour, sometimes spotted on the ends or sides; and sometimes the whole outside of the tuber was affected, which, when cut into with a knife, presented very much the appearance of the disease usually termed *dry rot*, which has existed for a number of years in the potato crop, causing large failures or loss after the tubers are lifted, and put up for winter and spring use in pits or houses. At the lifting season last year, the disease had seldom infected the tubers more than from 1-8th to 1-4th of an inch deep, of a light brown colour. If the tubers were now put up in ridges, and well ventilated to prevent heating, it seldom penetrated further, and the internal part of the tuber continued firm and white, having no appearance of decay. Many fields were minutely examined in August and September, and plants lifted every two or three poles, to judge of the crops. This was done in many parts of the district by judges appointed by local societies to determine the comparative merits of crops belonging to those competing for premiums; and in all plants so lifted, I did not either hear of or see a single case of disease; but when these fields were lifted in October, they were found generally diseased; and what in this is remarkable, is, that the tubers of the plants so lifted and put back into the ground were all healthy and sound. This seems to indicate that early lifting or removal of the stems, even before the tubers were quite ripe, might check the disease, although a great part of those that had not been disturbed were diseased. The weather during the spring of last season was dry and cold up to the month of July, during which month we had almost continued rains with cold winds, and it continued very much the same during the rest of the year. I very much doubt, however, if we can ascribe the disease of the bypast autumn to this peculiar state of the weather, from this consideration, that the disease was most virulent and destructive in the best sheltered and warmest districts, whilst those grown upon the uplands in cold bleak situations in the hills, were comparatively free from the disease, the greater part of the crops there having nearly escaped: neither do I think it can be ascribed to the influence of the soil of the uplands, as the crops upon soils of apparently the same character in the lowlands have suffered as severely; and if we ascribe the disease to the weather, how is it that the cold bleak islands and shores of the north of Scotland have escaped, whilst the crops are so much diseased in the warm and dry situations along our warm coast and drained lands of the interior; as also from accounts received, the potato crops in the warm dry lands of North America have suffered severely for years from this same disease. From the above considerations, it appears to me that we must look for some other cause than the wetness and coldness of the weather of the last season, or other atmospherical changes, for the appearance of this modification of disease. I think, instead of ascribing the disease of

last autumn to atmospherical causes, we are warranted in considering it to be a modification of that which has appeared in the tubers in autumn, and particularly in spring, for a number of years. I mean that disease which has for many years past appeared on the skins of the tubers in autumn, in the form of pocks or small brownish specks or ulcers, which, by spring, extend nearly all over the tubers, forming large ulcers, and causing a total blindness of the eyes and loss of vitality. This is a most dangerous disease, and has caused nearly the total loss and failure of many fields in spring, from want of a careful inspection of the tubers and eyes before planting. Large failures took place here from this cause in the years 1834-35-36; but from care in selecting the tubers, we have on this farm been entirely free, or nearly so, from spring failure for some years past; and I have reason to believe we have suffered less from the disease of last autumn in consequence.

This disease of blindness or loss of vitality, which I described in 1839, is, I have reason to believe, the same we lately suffered from, and which seems to have first commenced in a modified form. In looking over a paper I wrote upon the failure of the potato crop in the year 1839, I find the following description of this disease, which I had noticed and pointed out some years before, and which still describes its appearances. "This disease, which has caused such destruction to the potato crops of this country, may be even observed in autumn when the crops are lifted, but still better in spring when the pits are opened for planting. If the tubers be narrowly examined in autumn, this disease will be found on the skin in numerous minute specks of a dark brown colour, the rest of the skin appearing of a rather duller colour than a healthy tuber; but in spring when the pits are opened, the pock or ulcer in most cases will be found to have grown a great deal larger, many of them from 1-16th to 1-8th of an inch in diameter, and very often to have run in to each other, producing an ulcerated appearance all over the surface; if the eyes or buds are now examined closely, they will be found to be mostly blind; and if any of them should have sprung a little, they seldom grow further, but die upon exposure to the air. The tuber still retains its shape, and to a casual observer appears quite sound, the disease destroying no more than the skin and vitality of the bud; in this state it is quite fit for food, and is usually more firm and mealy than those tubers from the same heap in which the vitality is not destroyed." If tubers having the disease described above are kept for some time after the beginning of summer, this corroding of the skin sinks deeper into the substance of the tuber, and it then presents very much the same appearance as the disease of last autumn. In some cases where the pocks are not fully extended all over the potatoes, some of the eyes may have escaped, and will shoot but *weakly*; these, if planted whole, may produce weak and unhealthy shoots and tubers; and there is not a doubt, that, whether this disease is a modification of the present disease or a different one, it has caused many failures in spring when planted, and may probably have caused the present disease at the lifting season; but whether it is a different disease or not, that it causes an unhealthy state of the plant, there is not the slightest doubt; and that this may be conveyed to the progeny, is, I think, also probable. May we not either look with more reason to something of this kind for a solution of the cause of the disease of last autumn, than to any peculiar state of the weather; for, however well the crops of the north of Scotland and our uplands may have escaped the disease of last autumn, these situations have not been a safeguard to them from the pock and blindness which, from every thing I have seen, is more extended in the crops from these situations this season than I have ever observed before, many that I have examined being almost totally blind and ulcerated from this disease; even potatoes brought from Inverness and other northern counties for seed, where disease was said not to exist, I have found on inspection that they were not free from the pock or blind-eyes disease, nearly one-half being more or less affected with it. Now, if the murrain is a modification of the blind-eye and pock disease, it is not improbable but the murrain may yet appear in those northern counties, and particularly that there is every reason to believe that if the pock does not receive a check, it will, after a time, present the very same appearance as the murrain.

Query 2.—I am not aware that any variety has entirely escaped the disease in this district, I may say none, but some varieties are more diseased than others. The white blossomed cups are best adapted for making farina, as they contain a greater quantity of starch than any of the other varieties; having made trials of this some years ago, I found they exceeded the other varieties in quantity of starch, as six to four, and old Scotch white potatoes have suffered least, American early and rough reds come next, Berwickshire blues, buffs, and white dons, have suffered most. I am not aware that potatoes raised from seed are less subject to disease than those long raised from tubers; indeed, my own experience confirms that they are not; as some I raised one, two, and three years ago, were fully as much diseased

as the older varieties, and I have found that they have been as liable to fail after being planted in spring from pock and blindness, as any of the older varieties. Heavy loams and clay soils seem favourable to the disease of last autumn, both upon drained and undrained land. Potatoes grown upon new land seem less liable to the disease; light lands were nearly free from disease, particularly in elevated situations, as two or three hundred feet above the sea, as also on moss lands. Upon all the best cultivated and richest manured lands, the potato crops of last year suffered most; but this disease has likewise attacked the tubers of crops to which no manure had been applied. Where some kinds of chemical manures were applied to the crop in spring, although they may not have totally prevented the disease, still there were fewer diseased tubers amongst that portion of the crop to which they were applied than amongst those which were manured with farm-yard dung alone. A portion of about two acres of a ten-acre field was manured with a mixture of salts composed as follows:—one cwt. of burned bones were dissolved in half their weight of sulphuric acid; after standing for twenty-four hours, the following salts were mixed together and poured in amongst the dissolved bones, viz.; one cwt. common salt, one cwt. sulphate of soda, seventy-two lbs. sulphate of magnesia, and forty-two lbs. sulphate of ammonia; the whole was now well stirred up to incorporate them together, and let stand for forty-eight hours, and any extra moisture was absorbed by mixing with dry earth, saw-dust, moss, or wood ashes. The above quantity was given as manure for one imperial acre. The tubers upon this part of the field manured with the above, were completely free from the disease, whilst those manured with farm-yard dung in the same field were less or more touched with it. From former trials I had every reason to believe that by the use of these salts in combination, I had invigorated the diseased seed tubers in spring, and from their effect, as recorded above, in preventing the disease of last autumn, I have hopes that with a more extended experience of their effects, we may at least greatly alleviate if not totally prevent the ravages of disease in the potato crop, particularly if the cuts before planting are treated in the acid solution as is hereafter mentioned.

Query 3d. The usual mode of storing potatoes in large pits I always disapproved of, and have for some years stored my potatoes in narrow ones not above three feet wide, which may account for this farm having suffered less than many others in the neighbourhood; heating being so injurious to the keeping of the tubers; and for this reason I have further narrowed my pits, having proved this the most successful mode of preserving both healthy and diseased tubers of the last season. My plan was as follows:—Select as high and dry a situation as possible; make the surface smooth; mark off the ridges from two to two and a half feet wide, of any convenient length; upon the centre of these ridges lay a row of common drain tiles with cross ones reaching to the outsides of the ridges; every six feet upon these, ridge up the potatoes, bringing them up as narrow upon the top as possible; lay a divot or turf next the potatoes on each side of the ridge, to reach from the surface of the ground at least one foot up the sides (this being the part of the ridge where they are most likely to be frosted); thatch now all over with well-drawn straw to the thickness of at least six or eight inches, roping all securely down; this will be found to keep them quite secure in ordinary frosts; and if very hard, a little litter or waste straw may be thrown over them besides. By following the above method, I have been enabled to keep even diseased tubers in as good condition as when they were lifted, till the month of April. As regards the preventing of the disease extending from unsound to the sound tubers in the same pit or ridge, I consider there is no fear to be apprehended that this will take place, as I have had them lying together all winter, both in the houses and ridges, when, if not heated, no communication of this disease took place by their contact. I have also taken a slice from off each of them, diseased and healthy, and tied them together, and these healthy ones are now as free from disease or taint as when this was done. I have also limed a considerable portion of the last year's crop, but did not find any particular benefit as regards prevention of disease from its application; it had the effect, however, of making those which were rather watery in quality, dry and mealy, and of a most superior quality for table use. I might have mentioned here that numerous farina mills were put up in this district for the purpose of converting the tubers into starch; this, however, will not be found a profitable mode of consuming them, as it requires a considerable outlay of capital to fit up these mills and keep them in working order; besides, that the season for converting potatoes into starch is so short, that these mills must stand idle at least nine months out of the twelve; because, if not made before the end of January, a considerable loss of starch is the consequence; so much so, that whilst from 8 to 9 tons of tubers will give 1 ton starch at the lifting season, it will require from 20 to 25 tons to give 1 ton in spring. Having tried many

substances last winter and this spring for preparing the seed tubers for planting, many of which had been made the subject of experiment in former years, amongst others I would particularly recommend the following to the attention of the Society, and from having used it since the year 1843 with the greatest success, I find it this season particularly applicable in our present circumstances, and can recommend it for bringing away a quick strong growth in even particularly diseased tubers; it is also easy in practice, which is also worthy of consideration in a large establishment. Take a tub or tubs of any convenient size, but such as will allow of a common potato-basket to be dipped into them; put into these tubs 100 measures of water; add to this quantity either 2 or 3 of the same sized measures of sulphuric acid, and stir the water and acid together. Now, whether the tubers are cut or planted whole, put them into a basket, and dip them into this acid solution, keeping them in for about two minutes; drain the liquor off, and spread out the tubers; then dust them over with fine powdered quicklime. By so doing, you not only check any tendency to decay, but it has the effect of stimulating the growth of the tubers, which is of the greatest moment in spring, and destroying the disease. In proof of this, from diseased potatoes a parcel of cuts containing fresh buds or eyes were taken and prepared with the acid solution in October last year; these were found to have kept quite sound during winter, and were planted about five weeks ago, and are now springing strong and healthy to all appearance. With respect to fungi being the cause or merely the effect of the disease, there seems to be a difference of opinion; but be this as it may, if fungi exists at all, it will be destroyed by the dipping in the acid solution, and decay prevented, at least till such time as the shoots are above ground, and have made roots sufficient to nourish the stems independent of the seed cuts. Along with the above, I would also recommend shallow planting, which I consider of great importance, as the plants come away quicker and stronger, and ultimately give a larger and healthier produce.

No. 118.—Mr Allan Pollock Younger of Fauside. Broom, 30th April 1846.

1st. Previous to three or four days of almost constant rain, somewhere about the end of September last, there was no disease noticed in this district; and in one or two instances where the crop was nearly ripe by that time, although not lifted, there was, comparatively speaking, little disease.

2d. In several localities of low mossy ground, where the shaw at an early period of the season was blackened with frost, the crop, when dug at the usual time, was almost entirely free of disease.

3d. In most instances where the crop was very large, the disease was much more prevalent than when there was a scanty crop.

4th. Those stored with lime I have found to keep worse than where nothing was applied, and the smaller the pits the better; but I think those which were allowed to remain in the ground undug till lately, have decidedly kept better than any other. No doubt the season has been peculiarly favourable for that method, as we have had no frost.

5th. I know very little difference in the amount of failure in one kind of potato more than another; if there is any, I should say the cups have kept best; the buffs worst; and the different red and white kinds much alike.

ROXBURGHSHIRE.

No. 119.—Mr George W. Hay. Whiterigg, 17th March 1846.

It gives me much pleasure to be able to say, that I am but ill qualified to give answers to the queries sent to me through you by the Society, as I have very few diseased potatoes among those cultivated by me this year; the reason of which I ascribe in a great measure to having planted the previous year on new land—land which had been in grass for a great number of years, and which grew a very luxuriant crop, and of course, when lifted, were not fully ripe.

That crop consisted of the old blue or black potato, which has been degenerating for many years, the early American, a few of three different kinds which a friend sent me from Berwick, out of a shipload which had been brought for seed from Perthshire; two of which kinds did well; the other was an entire failure, the drills having to be sown with turnips. Another kind which I had was originally black throughout, and which I ob-

tained from a friend near Edinburgh three or four years ago; and a curious circumstance regarding them was, that the first year they grew on my land, they turned up a pinkish white with a fine pink coat; the next year they were pure white and beautifully mealy, not a black one among them; for a year or two a few of them had a slight pink streak through them, but that has disappeared. This kind has always been a free grower, last year producing a very heavy crop, and this year the crop has also been good, though I had very few of them planted, in consequence of my people disliking their white appearance. A friend in the neighbourhood got a parcel of them, and I understand that they were the only ones which succeeded with him this year.

All the kinds which I have enumerated grew very luxuriantly, and flowered freely last year; this year, on the other hand, the same potatoes being planted, the stems neither grew strong, nor did they flower at all. I believe I did not see a single flower this year, but the stems were covered with growths, evidently malformations of the side branches and leaves of the main stem, caused by the superabundance of sap. I have often seen these upon the stems of potatoes, but never to such an extent as this year; and they were generally about the size of a pigeon's egg, which I had purposed gathering with a view to autumn planting, to see if they would produce a crop; but the early frost which did so much damage to the stems, injured these also, so I did not like to venture.

My crop this year was not large, as the crows had been very diligent upon them from the time of planting; and the field being out of the way, could not be properly protected. There was, however, a fair crop from the stems left, and the potatoes escaped the disease to appearance at that time. They were very carefully picked, throwing aside all the crow-picked and worm-eaten ones, together with the small ones which were planted without manure about the middle of December, on a portion of the same ground from which they were lifted; they occupy about a quarter of an acre, and I am enabled to say, that they are all, as far as I have examined, in a good state, and springing; and this will be the means to a certain extent of testing both seed and soil.

The large potatoes, which had been picked, were pitted in the usual way, with a covering of straw and earth above; the only difference this year from former years being, that wisps of straw were put here and there through the tops of the pit, to allow of ventilation. After a time, when rumours were afloat of a neighbour's pit having fallen in, I was induced to have my pits opened and carefully examined, and out of about 150 bushels, about one bushel of diseased potatoes was taken; and when they were opened a short time since for the purpose of bringing a portion into the house, they were again examined, and about the same small proportion found wrong.

Those which have changed colour were in a small pit by themselves, and on examination were found quite healthy; and these, with a few early American which were in the same pit with the blues, and also healthy, I purpose planting as soon as I can have the ground ready; whether in the same ground as last year, or in a different field, I have not yet determined.

I may remark that this year the potatoes were grown in a free turnip soil, whereas last year they were in a stiff clay wheat soil, the seed with which it was planted having been raised in the very field, though not on the same portion of it, to which the seed was again returned this year, so that it is somewhat singular that the crop has escaped, and it will be more singular still, if those I have again planted on the same soil for next year's crop escape.

You will perceive that I have used the term this year, meaning 1845, and last year 1844, with next year 1846, which I mention that there may be no mistake of the years.

I have kept myself exclusively to my own crop, considering that such was the meaning of the circular. At the same time, I may state that the disease has been very prevalent in this quarter, more especially in the gardens of the villagers (Bowden), where scarce a good potato is to be found.

No. 120.—Mr William Ogilvie of Chesters. Branxholm, 20th March 1846.

This district of the country was much affected with the potato disease. I am of opinion that it has been much influenced by climate and soil, and certainly inversely with the height of the country where the potato is planted; and on *peat soil* the disease scarcely appears at all.

The most successful means that I have seen adopted to preserve the healthy tubers, as also to arrest the progress of the disease, was to thoroughly dry them in the open air, and store

them in narrow well-ventilated pits, covered as usual with straw, and six inches of earth. I have preserved a few equally well, and perhaps better, spread out in a well-ventilated granary; but this requires more accommodation than can well be afforded.

I tried the experiment of cutting off the soundest and freshest-looking eyes from the diseased tubers, and placing them in layers of *dry sharp sand*, in narrow well-ventilated pits; and on opening them last week, found they had kept extremely well, and throwing out vigorous shoots. These of course are now ready for seed.

I also stored some with quick-lime, but they did not keep well, also some with chaff and cut straw, in a potato house, and they were equally bad.

No. 121.—Mr Robert Nisbet of Lambden. 28th March 1486.

My potatoes were planted at the usual time on a piece of fertile loam, in a low situation, and had 3 cwt. of guano, with 12 single cart-loads of farm manure, applied to them per imperial acre. The crop looked most promising until the beginning of August, when the disease made its appearance by a space of about ten square yards becoming dark and blighted in the shaw, from whence it extended itself on all sides, and had completely affected the whole crop in the space of three weeks from its first appearance; and although some kinds, such as second early and Irish cups, have suffered less, yet all have been affected, the least so to the extent of one-half; and having tried various ways of keeping them, I would recommend their being laid upon a barn floor and frequently turned over, picked, and divided into heaps, according to quality, and applied to suitable purposes, such as the table, feeding of cattle, pigs, &c.; and where the soil is dry, would also recommend a quantity being left in the ground for seed the following year, which I did last season, and intend making use of the sound ones for that purpose (which I have examined and found in a very healthy state), in preference to those that have been pitted.

No. 122.—Mr John Dudgeon. Spylaw, 18th March 1846.

Query 1. I consider it was not until late in the season that the disease manifested itself here; certainly not before considerable agitation on the subject had been exhibited in other quarters, was it admitted that any disease prevailed at all. Indeed, so little attention had been given to the matter, and the disease may be said to have been so slight, if it prevailed at all previous to the ordinary season of lifting, that that process was in general well advanced before the discovery of any taint; so much so, that in many cases considerable loss accrued in consequence of ignorance of the disease, and no precautions having been used in pitting. Thus no observations that I am aware of had been made as to any peculiarity in the appearance of the stems, leaves, and flowers; but I may mention, that although I never recollect to have seen so rich a developement of flower on my own crop as in this season, it was observed there was scarcely an instance of any fruit (apple) having been formed. The tubers tainted—visible on being taken up, perhaps in not more than one in eight or ten—showed a slight discolouration on the skin, which, when cut with the knife, appeared to extend little beyond the surface, and exhibited an appearance very similar to the wound on an apple occasioned by a fall or bruise.

Query 2. The varieties known here as Irish cups and second early have been much less affected than the darker skinned kinds, dons and blues. I am not aware of any difference having been observed as to the effect of the disease on roots recently raised from seed. As a general remark, no distinction seems to have been noticed as regards disease, traceable to the state of the soil in respect to previous cropping, or wetness, or having been previously drained. I have heard that insufficiently prepared farm-yard manure had proved prejudicial, though, I am inclined to think, perhaps not more unfavourably adverse than, in comparison, such an application might be expected to account for in ordinary circumstances. My own potatoes were this season planted after an application of guano in the drills previously lightly harrowed down, the land having been also winter-dunged slightly with farm-yard manure. The crop was fully less affected with taint than many of those around me.

Query 3. Any process by which the tubers are deprived as quickly as possible of artificial moisture, seems best calculated to prevent the spread of disease. The usual accommodation on a farm steading, does not admit of so bulky an article as potatoes being spread out in such a way, under cover, as best to facilitate this process, otherwise this might be first recommended. But I have found that potatoes can be pretty rapidly deprived of extra moisture, by being put up in narrow heaps on the surface of the ground, in an exposed

situation, in the first instance slightly thatched or covered with straw, to be added to as the season advances. No earth ought to be put on pits containing partially diseased roots, at least until they are found to be completely dry. As already alluded to, great loss was experienced in many places in the district from pits having, in ignorance of the existence of disease, been made up and earthed over in the usual way immediately upon the roots being raised, by which, from the spread of taint in the diseased tubers, a heat was communicated to the store, which resulted in the fermentation, and consequent destruction, of the whole mass. It is not supposed that otherwise taint is communicated in the pits to the sound potatoes, though the extension of incipient, and what is at first scarcely perceptible, disease, no doubt gives *an appearance* of an increased number of tubers having been affected. I had an opportunity of seeing the other day a quantity of potatoes raised which had been left all winter in the ground, a portion, each alternate drill, having been pitted and earthed up in the usual way in autumn. The number of sound potatoes seemed fully more as left in the drill during winter, and were certainly in a more pleasing and fresh condition than those in the pit.

ROSS-SHIRE.

No 123.—Mr Charles Barclay. Inchbroom, 23d March 1846.

There having been no disease in the potato-crop in this neighbourhood, nor under my observation last season, it would be great presumption in me to say a word on the subject, further than highly approving of the Highland and Agricultural Society of Scotland acquiring all the information possible, and doing every thing in their power to prevent the recurrence of so great a calamity.

No. 124.—Mr Duncan Davidson of Tulloch. 22d April 1846.

Although there is an evident reluctance on the part of many growers to admit the fact of taint existing in their stored potatoes, I have examined minutely many such, and, almost without an exception, have discovered the infection. I do not pretend to account for this disease—the weather was most probably the cause to a great extent—carelessness in the selection of seed another.

I have met with many who said, on my pointing out the disease to them, "Oh! if that is the taint, we have seen it for some years back." No doubt that, in this county, the disease has not been so violent; in other words, the decay has not been so rapid as in some other counties. I examined many pits before Christmas—and in some of my own pits I observed the commencement of disease. I had a large quantity removed from the field to a cool and sheltered barn-floor, where the potatoes were thinly spread, and where there was a current of air. Those treated in this manner decayed very much faster than those left in the field in pits The sorts were various—Irish cups, dons, buffs, and a sort I got from the late Sir Francis Mackenzie of Gairloch—there was no decided preference to be given to any—they were mixed, and all seemed to decay with the same extraordinary rapidity. I feel quite confident that the disease is infectious, and however much lime may check the disease, it does not cure it.

The potatoes most pure from taint, which I have seen, are some "Jersey reds," not a very esteemed kind in the London market, they were grown by Mr Denham, a tenant of Mrs Stewart Mackenzie's, on the Brahan property.

The course which I have adopted, and which I would recommend others to adopt, is to be most careful in selecting for seed such potatoes only as are quite free from all appearance of taint,—these I cut into eyes, and directly they are cut, are placed in a sieve with a small quantity of lime, in which the cuts are rolled till they are well powdered,—this checks all *bleeding*, as we term it here, and dries up the wound. The next day I plant them, not too deep, and *not* touching the manure, which I hold to be of vast importance.

I have planted a quantity of potatoes—some whole, some cut, many weeks ago—both are growing well, and see no difference in them. This is, I know, contrary to Sir R. Anstruther's opinion. My experience, founded on practice of 20 years, is to prefer cuts to whole potatoes, unless the latter are very small.

I have both whole and cut potatoes in pots, subjected to slight artificial heat, all above ground.

With a view to have good seed, if possible, I have planted selected seed of "Jersey reds, buffs, and dons," on land laid down last year in grass, without any manure; and it is my intention, before the tubers are quite ripe, to lift them, and expose them to

the action of the sun and air, and they will assume a green appearance; when fairly dry, I shall pit them, placing divots of old grass next to the potatoes, the grass side inwards, and straw and earth over, to protect them from weather and injury.

I observed that in my pits, where straw was placed next the potatoes, the straw in a short time became quite wet, *almost dung*; and those pits which I examined, where divots were used, were decidedly the freest from taint. I have planted about 30 acres of potatoes this year, and if it will be of the least use, I shall gladly communicate the result of any observations I may make to you in the autumn.

STIRLINGSHIRE.

No. 125.—Mr James Buckie. Lauriestown, 12th March 1846.

Curl in the potato-tops, is caused by planting potatoes on ground near, or on a level with the sea. You may get potatoes from a high and healthy district, on a level with the sea, they will all be curled the third year.

I observed no potatoes affected before Friday the 26th September, last year, when showers of hail, with flashes of fire, fell on that day, and several flashes for nights after I was lifting potatoes last August and September, and found, after the 26th of September, the potatoes to alter in taste and smell.

I conclude by saying, it was hail and fire that smote the root of the shaw or tops and the juice or sap of the shaw going down into the potato, below ground, caused the disease or rot. I found, in all cases but one, the more luxuriant the tops of the potatoes, the more were roots or tubers affected. The one exception was potatoes from Lima, South America; they were quite green in the shaws, and were not affected at all in the tubers, which shows they were able to resist storms. In the other varieties of early kinds, all their shaws were withered, and no sap went down to the tubers, which were all sound. The other kinds of late potatoes, droppers, where they were withered in the shaw, were not diseased; while the same kind of potatoes, that had larger tops, were diseased. The Perth red and Glasgow red, with the cups, the reds especially, wither soon in the shaws, and there is little or no disease in them. I saw the farmers in this county lifting their potatoes that had been in the ground all winter, which was dry, and about one-third were diseased; the other two-thirds were fresh and sound. In Linlithgow county I saw potatoes lifting last Tuesday, I examined them likewise, and found about a third diseased, and the rest good. They have kept better in the dry soil, than lifted from a similar soil; and when separated the good from the bad, and laid up in pits or lofts, a great many have become diseased and not fit for use I wrote to the *Edinburgh Weekly Register* last April, that our potatoes are decayed all over Scotland—I think degenerated—and that we have lost some of the best qualities in consequence of the late cold summers, namely, from 1835 to 1842 It appears to me that potatoes are easily hurt, and not able to bear what they did before.

No. 126.—Mr Peter Blackburn of Kilearn. April 13th 1846.

The ground I planted with potatoes in 1845, extended to about 16 acres of flat alluvial soil by the river side, (what is called a haugh,) and is of good quality; the previous crop was turnips, when the ground was manured with farm-yard dung and about 2 cwt. guano per acre. The potatoes were planted with a moderate allowance of dung on the following dates:—

May	6th,	4	bolls	calico	potatoes,	
—	7th,	do.	do.	red	do.	
—	8th,	do.	do.	buff	do.	
—	9th,	the rest of the ground		blue	do	in about equal quantities.
—	10th,			& yam.	do.	

On the 17th of June there was sown over them about $1\frac{1}{2}$ cwt. per acre of a mixture of common salt, sulphate of magnesia, and sulphate of ammonia in equal quantities. The shaws of the potatoes never looked very strong, but nothing appeared to be wrong about them, and on the 29th September we raised $\frac{1}{2}$ boll of the buffs and $\frac{1}{2}$ boll of the blues, when there was apparently no disease. Immediately after that, the Endrich rose to an unusual height and overflowed the field, and when it ran off and the ground was dry, we began to raise the potatoes, *i e.* on the 11th October, at which time there was scarcely one without disease, the blues worst, calico next, then the red, the buffs next—the yams being the best, but very bad too. I tried various

ways of keeping them: on a barn-floor, spread thin, and in very narrow pits, but found neither succeed. As many as possible were used for feeding the milch cows and cattle generally, and with no bad effect. By the beginning of January the whole that remained were quite rotten. The potatoes on a similar piece of ground belonging to one of my tenants, and which was also flooded, are the only ones which have been so badly affected in this neighbourhood, so I consider the flooding to have been the principal cause of this bad pre-eminence. But at the same time, the good quality of the soil, and being well manured, seem to add to the virulence of the disease, as those grown on the poorest and worst ground on the muir edge are the least affected.

No. 127.—Mr Charles Stirling of Muiravonside, Linlithgow. March 21 1846.

Throughout the last week of August and the first one of September 1845, the weather in this district (the eastern district of Stirlingshire) was most beautiful, fine dry, and warm. Some of the farmers on the earlier lands in this neighbourhood had commenced their harvest operations. I had nothing ready to cut, and foresaw I should have nothing for ten days or a fortnight to come, and somewhat annoyed at not being able actively to profit by this fine weather, it occurred to me, particularly as my people were idle, whether it might not be well to take up my potatoes and secure them while the weather was good. The shaws had begun to decay, and I considered the tubers could derive no further benefit from them, and if the weather should break, I might not again have so fair an opportunity of lifting them; and at all events it would be putting so much work out of the way. When I spoke to some of my people on the subject, they exclaimed against it. They said it would never do; that such a thing as lifting potatoes before the corn was got in, was never heard off; that they would not keep; that potatoes ought to remain in the ground for some weeks yet, in order to dry and get seasoned. Not altogether satisfied with this reasoning, and believing that, with care, the potatoes might be dried as well above ground as below, and at all events it would be trying an experiment which might be useful on some future occasion, I determined on lifting them.

Accordingly, on Monday 8th September, all hands started to lift the potatoes—they were taken up perfectly dry and clean, not a particle of soil adhering to them—they were handled very gently, to prevent the skins being chafed, put into sculls (*i.e.* baskets), and so carted away. About two-thirds of the crop were stored in a granary, a wooden building, having a boarded floor raised about 18 inches above the ground, so there was a free circulation of air underneath, and the air passied freely through the interior. The other third was stored in some out-houses, the floors and walls of which were rather damp.

I may here mention, that while my potatoes were being lifted, nothing was observed to be wrong in them, and at that time there was no suspicion entertained by the people, that any potatoes in this neighbourhood were affected. It was believed that all was safe on that head. A few weeks after this, however, the face of things began to change, first one man's crop was said to have shown syptoms of disease, then another's, till at last, spreading like wildfire, there was not a crop but was said to be be more or less diseased. About this time, one of my own people, an industrious skilful hand on the farm, and to whom I had given permission to plant his own potatoes on a ridge adjoining mine, in the same field, but who, confident in the belief that it was necessary that potatoes should remain long in the ground to harden and season, had scouted the idea of lifting his when I lifted mine; addressed me, and said "I wish, sir, I had followed your plan and lifted my potatoes when you lifted yours." "How is that," said I, "there is nothing wrong with yours, is there?" "Indeed, sir," said he, "I am sorry to say there is, for I have been examining my potatoes, and I believe they are more or less tainted from one end of the ridge to the other." This man lifted his crop soon after; he had what he considered a very good crop, in point of quantity, about 12 bolls. This was much more than he and his family could have consumed, had they been good; but as it was, his family and his pig consumed the whole edible part of this lot of potatoes by about the middle of January; since when they have been without any. He early foresaw that he should be able to keep none for seed, and asked me to let him have a boll for that purpose, which I did. He took them away about the time I stored mine for the winter, and pitted them in a dry place in his garden. He told me the other day that he had been taking them up and examining them when he only found *four* potatoes touched with the disease in the boll. I have dwelt longer than I ought to have done, perhaps, on this man's story, but there are circumstances in it worthy of attention; for instance, it shows there was nothing in the soil or situation to prevent infection. It shows, that whether the disease is conveyed to the tubers by the descent of the sap, or by lying long in the damp soil, the lifting the potatoes early and in dry weather is a check to the disease. It also shows, in the boll

he got from me, that where potatoes have had the disease checked in time, and well dried, they may be afterwards pitted, in a dry place, with comparative safety.

Begging pardon for this long digression, I now proceed with the account of my own stock. The beginning of November I ordered a survey to be made. The potatoes stored in the out-houses were found to be going very fast; and, separating the bad from the good, the former amounted to about 1-4th or 1-5th. The granary was next examined, there were a few touched, but, on being picked out, I should think not more than 1 in 500. To store them for winter and protect them from frost, I had the sound ones taken to a spare airy stable, the floor and walls of which were free from damp. There they have lain all the winter, loosely covered with straw. Twice they have been overhauled, and each time a few, but a very few, have been found touched with disease, and those that were, were generally such as had received damage in the lifting. The remainder, to all appearance, are as sound as potatoes can be.

I am not capable of giving any account of the disease scientifically, either as to its origin or progress; but I am in a condition to give practical evidence in favour of Professor Playfair's recommendation as to coolness, dryness, and separation of infected tubers; also to bear testimony and give confirmation to Lord Portman's excellent paper, on the same subject, in the Journal of the English Agricultural Society (vol. 6, part 2.)

The plan I intend to pursue this year, is to lift my potatoes as soon as I see the shaws beginning to wither, or in other words, when the sap is beginning to descend, provided always the weather and the ground be dry. If not, I rather think I shall adopt Lord Portman's plan of cutting the stems close down to the ground, to check the descent of sap, and not lift the potatoes till I can get them up *dry* and *clean*. I lay great stress upon these latter points, being convinced it is half the battle to put them up dry and free from all adhesion of soil; care being taken to handle the tubers gently, so that the skins be kept sound.

I shall probably store mine again in the granary, but I do not consider that necessary. They may be stored perfectly well out of doors. I think laid on a dry bed of any kind (if open, so that the air may pass through, so much the better) and the heaps so formed that the air can pass freely through, covered from rain, both top and sides, in an airy situation, till frost may be expected, when, of course, means must be taken to protect them, I have little doubt of their preservation.

I neglected, in the body of my letter, to say any thing as to kinds. The fact is, I had seven or eight sorts—rounds and kidneys, white, red, and blue, some old potatoes, pedigree unknown, some raised by my gardener from seed, and planted in the field for the first time three years ago. I observed no difference as to kinds in the attacks of the disease. All kinds in the outhouses were attacked, all those in the granary sound. The only ones that I could say were not attacked, were the *small* potatoes of every kind, such as did not exceed 1¼ in diameter.

SELKIRKSHIRE.

No. 128.—Sir JAMES RUSSELL of Ashiesteel. 20th March 1846.

1st, The disease was partially observed in the early part of September, and generally after a frost which occurred on the 23d of that month, preceded by rain and cold, excessive for the season The leaf first became affected with brown spots, which proceeded to general decay, and the tuber, on being taken up, exhibited white spots resembling mould, on the diseased parts.

2d, The kidney, and early American kinds, used for my own table, were *perfectly sound and free from disease;* and a kind called Catholics, and a coarse Irish sort principally used for cattle, escaped without much injury; all the other ordinary varieties were considerably affected, and a few recently produced from seed, were fully as bad as those that had gone through a course of culture. The soil and treatment of the crop at this place, was, as far as possible, alike, and none of the differences of result can be traced to these causes.

3d, The greatest collection of potatoes here, has been kept in an excavated cellar, which, being on an abrupt declivity, is open at one side and one end, with ventilating shutters, well adapted for the preservation of roots, which, in all ordinary cases, it perfectly ensures. The potatoes in it have been occasionally examined, and the worst of them removed, and it does not appear to me that the disease has extended during the period of storing, though the bad may have become worse. Others, which were pitted, and periodically inspected, came under the same observation. The capricious action of this disease, which baffles all ordinary calculations, much reminds me of the fantastic operation of the Asiatic cholera on the human subject

which I had an opportunity of witnessing from its commencement to its decline, equally inclines me to attribute it to causes purely atmospheric; and it might therefore be matter of curiosity, though it could be of little general use, to try if a few roots, especially of the late kinds, secured as far as practicable from the action of the air, were equally liable to it.

SUTHERLANDSHIRE.

No. 129.—Mr Alex. Craig. Kirkton, Golspie, 14th March 1846.

Potatoes are not much cultivated in this county. Those farming arable land, are, with few exceptions, also extensive holders of sheep pastures, and therefore find it for their interest to have the whole fallow-break under turnips, except what is absolutely necessary to supply the farmer's family and servants with potatoes.

In Sutherland, the potato disease, (as far as I can learn,) is entirely unknown, except by report from more southern counties. The limited breadth of potatoes planted last year turned out an excellent crop, in every respect as to quality, although in certain situations the quantity was not so great as in some former years. I and some of my neighbours have been in the practice, of late years, of planting our potatoes upon a portion of the grass lot intended for oats. We did not at first adopt this system with the view of improving the potato crop, but for the purpose of enabling us to save the same quantity of the fallow break, and thereby have so much more under turnips, and at the same time have the land effectually cleaned, (for potatoes, with the best attention, are a bad cleaning crop;) as the whole lot, not only after oats, but potatoes also, is next year sown with turnips; and situated as the Sutherland farmers are, a few additional acres of turnips are to them of more value than the same extent of oats. As mentioned before, although I did not *at first* contemplate any benefit to the potatoes from being planted on grass land, I really consider the potato drier and of better quality than those I used to plant on the fallow-break, and perhaps the *change* might also be the means in some degree, of checking the disease when it unfortunately prevails.

I may further state, that the three or four acres of grass land to be planted with potatoes require to be well pulverised by being ploughed soon after harvest, and then cross-ploughed and securely harrowed early in February, and again ploughed and harrowed previous to being drilled up for planting. I am an advocate for early planting, that is to say, as soon as the land is sufficiently dry.

I expect to see many of the agriculturists of Sutherland at a meeting of our Farmers' Club on the 31st inst., and I will bring the subject of your communication under the notice of the meeting, and if I can elicit any information which I think may be useful, I will have much pleasure in communicating the same to you.

No. 130.—Mr George Gunn. Rhives, March 28th 1846.

I beg to state my conviction, that the disease which has been so ruinous and widely spread in other parts of the kingdom, has not appeared in any one case within the bounds of the county of Sutherland; our potatoes never being more numerous and of better quality than the crop of 1845.

No 131.—Mr Robert Horsburgh. Edinburgh, 12th April 1846.

Though there has been, as usual for several seasons past, a certain degree of rot among the last year's crop of potatoes, arising from bad storage or other causes, there is fortunately, as yet, no appearance whatever of the prevailing disease or taint. The crop was considerably beyond an average in bulk; and though the season was unusually wet, its quality has notwithstanding turned out to be very fair indeed.

For many months past I have been doing every thing I possibly could to induce the Duke of Sutherland's lotters, to take proper care of the potatoes intended for seed, and to bestow much more than the attention usually devoted to its selection. I have now reason to believe, that the necessity for precautionary measures is generally felt; and I am glad to learn, that more than the ordinary quantity of potatoes will be this year planted in the district of which I have the charge.

WIGTONSHIRE.

No 132.—Mr John Dinwoodie, Overseer at Glasserton. 20th April 1846.

On 1st and 2d July 1845 there was a severe storm of wind and rain, which broke the stems of the potatoes, from which they never recovered, and this appeared to be the forerunner of the taint or disease. From 12th to 20th of August the weather was dark and damp, with frost at night, which probably had a bad effect on the plant, after the stems were broken; but the stems though kneed grew vigorously afterwards. On the 20th August I observed the leaves covered with yellow spots, and the flowers falling off. Upon pulling some stems, small potatoes came up attached to the fibres, and on taking up the large potatoes which did not lift with the stem, they were found, when cut, to be of a brown colour under the skin, and when tried to boil, remained quite hard, or rather became harder, and those in this state commenced to rot when the general crop was taken up in October. High winds are very hurtful to the potato crop when in full vigour of growth, and the injury, no doubt, depends much on the weather following the storm which breaks the shaws.

The potatoes planted at Glasserton, cups, buffs, and Lothian blues, all suffered from the disease alike; I could not say one kind was worse than the other. A part of each were planted in land under rotation, in the usual manner, in drills; and a part in land newly broke in, thoroughly drained, and planted in beds; the manure used was farm-yard dung, with a portion of guano; the disease appeared the same in the crop on each kind of land. I planted in the same land, and with the same manure, American early and Taylor's forty-fold early potatoes (the seed of the latter was got from Messrs Jas. Dickson and Sons, Edinburgh, three years ago,) and both kinds when taken up were quite free from disease. I put them them in pits, covering with straw and earth in the usual manner, on the 20th October 1845, and took them out on 27th March 1846, and found them quite sound. I think the stems of the early kinds of potatoes, being small, were not broken or injured by the storm of 2d July, and the plant being nearer maturity was in their favour.

In storing the potatoes, they were put in small pits and covered with straw and very little earth, and when opened about six weeks after, I found the tainted tubers getting worse. I separated the good from the diseased as perfectly as possible The tainted ones were given to pigs, and they ate them greedily; the good were spread on an earthern floor, about eighteen inches deep, and turned with a wooden shovel once every two or three days until they became dry, keeping the door of the house open during the day, and shut at night; and those kept in this manner are as fine mealy potatoes as could be desired.

It would appear that diseased potatoes will not in all cases affect really sound ones. Into a heap of rotten potatoes which were laid aside as totally useless, I put about a stone-weight of good sound ones, and at the end of a month after, took them out as fresh as when put in, and they were even commencing to grow. I would, however, recommend no diseased ones to be put up with sound, if possible.

Some farmers in this neighbourhood left a part of their potatoes in the ground during the winter, where they have kept well; and there was of course no expense incurred in picking and sorting, as with those raised; but this might not answer in the case of a severe winter.

REPORT ON TRIMINGHAM AND RUNTON PLANTATIONS, in the County of Norfolk, belonging to SIR EDWARD NORTH BUXTON, Bart.

By Mr JAMES GRIGOR, Nurseryman and Land Improver, Norwich.

[Premium, Medium Gold Medal.]

THE following report is founded upon several plantations formed by the late Sir Thomas Fowell Buxton, Bart., in the parishes of Trimingham and Runton, situated in the northern extremity of Norfolk, close to the German ocean. Though this county is considered to be in general without hills and dales, the surface of the district now under consideration is bold and irregular, and unlike any other part I have observed in the east of England. For the sake of those who are unacquainted with the particular situation of the plantations I am about to describe, I may mention that they stand on elevated sites, opposite to, or facing, that dangerous part of the coast, full of hidden sand-banks, known as a continuation of the "Yarmouth Roads," a tract which has become alike dreadful to the mariner and merchantman.

The first efforts to cultivate trees in this district, were made at Felbrigg by the Right Honourable William Windham, the distinguished statesman, about the year 1781. The performance of the work was entrusted to Mr Nathaniel Kent, author of "Hints to Gentlemen of Landed Property," and reflects considerable credit on that experienced planter. It is to be remembered, however, that Felbrigg, and the greater part of the lands belonging to it, stand away from the sea-breeze several miles, so that none of the trees are subject to its immediate influence.

When Sir Thomas Fowell Buxton commenced planting, the present proprietor of the adjoining estate of Felbrigg (arguing, no doubt, from the hard task he himself has had in rearing trees) assured Sir Thomas that he would find the undertaking not only a most difficult one, but that in the situations which he had selected, being so close to the sea, the probability was that he would not be able to get many of the plants to live. With regard to one piece, (the Boreas plantation,) he was told that "he might as well plant his walking-stick as any thing else, for that nothing could survive the sea-breeze continually sweeping over it." The necessary preparations, however, were made; and it must be here observed that one of the most fortunate occurrences connected with the formation of these plantations, was their being entrusted to a person who perfectly understood the process of planting in all its branches. Ignorant or careless practitioners do not scruple to let plants lie about for days exposed to wind and frost,

or to bury them whilst in bundles, instead of loosening them, and letting them have the benefit of the soil, or to treat them in a thousand other ways, so as to kill them. But, in the present instance, the greatest possible attention was bestowed, both upon the plants, and the preparation of the ground; and, as will be shown in the sequel, the results have been highly satisfactory.

Many persons unacquainted with the nature of the soil, its exposure, and the almost insuperable difficulty there exists in getting trees to shoot vigorously beside the sea, will be apt to say that unnecessary expense has been incurred in trenching the land; but I am inclined to believe that a less costly mode would not have led to the same gratifying results, and I have come to this conclusion on the following grounds:—1st, About six inches from the surface there is a hard crust or *pan*, as it is called here, of red sand-stone, almost as hard as iron, which, if not broken up, offers a complete barrier to the roots of trees. Regardless of this obstruction, and fancying that plants might be inserted here by the hand-iron, in the same way as they are generally done in Scotland, a contractor from the north undertook to plant a tract of land in the neighbourhood without preparing it by trenching. The result was, that at the end of twelve months, three-fourths of the plants gave no sign of life at all, whilst the remaining number maintained a struggle between life and death for a year or two longer, leaving only a very few to subsist on the shallow portion of soil on the surface. 2dly, In order to furnish plants with the means of braving the sea-breeze, it is necessary that they should have every facility given them to strike their roots freely and deeply into the soil, for a plant which is pinched both below and above, cannot be expected to succeed well. It appears to me, therefore, that the policy of carefully preparing the soil for the reception of the plants was unquestionably good. I am perfectly aware of what is done yearly in Scotland by the simple process of planting two years' seedlings with the *planting-iron;* but as I have already observed, the adverse circumstances connected with the work under review, forbade any such experiment, more especially as it had been tried unsuccessfully on a neighbouring estate.

The geological features of the tract of country occupied by the plantations of Trimingham and Runton, are well defined—the high cliffs in the immediate neighbourhood showing at once the nature of the underlying formations. The lowest stratum which has been reached in this district, is the carr-stone, or iron sandstone, corresponding with the *green sand* of other places, and known to mineralogists as the titaniferous oxidulated iron-ore. It is used extensively in the west of Norfolk as a building material, one of the largest mansions built of it being Hillington Hall, near Lynn. Its effect, contrasted with the quoins, pediment,

battlements, &c., of white brick, is highly picturesque. Over this mass are layers of chalk; first, at bottom, the red chalk, interspersed with quartz pebbles, and corresponding with the "chalk with quartz grains" found at Lynne Regis, and in several parts of Yorkshire; then the chalk marl, of a gray colour, over which is a layer of hard chalk, which is so compact and durable, that it is used along with the carr-stone in building houses. In this last layer have been found the jaws and teeth of a large Saurian animal, identical with those found in the Sussex chalk, and figured in the *Geology of Sussex*, t. 9, f. 6. In Trimingham cliff, close to the plantations, shoals of the remains of testaceæ, chiefly *Ostrea canaliculata*, have been found in this layer. The uppermost series of chalk is of a loose texture, containing flints arranged in single horizontal layers about four feet asunder.

The next series of deposit, referable to an antediluvial period, is a thin layer of ferruginous gravel reposing on the chalk, and which may be traced at intervals at the base of the cliffs from Trimingham to Sherringham. It contains wrecks of a forest, such as trunks and branches of trees, fir cones, leaves, and various seeds, also the tusks, teeth, and bones of the elephant, ox, horse, &c. These may be observed during low water, and are so commonly seen, that they are justly considered as indicative of the extent of this series. Over this is a marine formation, here called *crag*, containing a thick bed of testaceous remains, leaving little doubt on the mind that the district now under consideration was at one time a branch or estuary of the German Ocean, a position that is considerably strengthened by the fact that the littoral shells found in this series correspond with those abounding on the coast of Norfolk at the present time. Superincumbent on the crag, is a stratum of blue clay, containing its characteristic fossils, ammonites, and gryphesæ. Its loose nature, acted upon, on the one hand, by the sea, and on the other by land-springs, renders it most insecure as a bulwark to protect the inhabitants and their property in the neighbourhood; and as yet no permanent stop has been put to the encroachments of the waters. Over the clay is a bed of gravel, varying in thickness from fifteen to thirty feet. This gravel is of the poorest description, consisting chiefly of small water-worn pebbles, cemented together by the oxide of iron, and in some cases so hard, that large pieces may be thrown with force to the ground without being broken. It is always hardest on the surface, which forms the pan or crust so often referred to by those who are employed in planting and in reclaiming waste lands in this quarter. This gravel forms the subsoil on which the trees in the plantations I am about to describe have to rely for a great part of their support. In particular cases where it is otherwise, I shall take care to mention the circumstance.

But, though the prevailing geological features of the district are as here described, there are instances in which the appearances of certain strata render it evident that at one period or other, a disruption and actual transportion of the layers had taken place. Thus, enormous isolated piles of chalk are in a few cases found *above* the ferruginous gravel and crag. Not far from the Light-house at Cromer is one of those mounds, the bottom of which is 200 feet above its natural level, and on this spot excellent lime is burned; another at Runton is 80 feet thick; whilst a second in the same district is 100 feet high. Again, amongst the gravel, which forms the ordinary subsoil of the land at the present day, are found large flints disengaged from the chalk to which they naturally belong, an evident proof of the violent eruption of the several strata. From the extraordinary positions assumed by the layers, in those minute cases, it is impossible to form any geological conclusions regarding them.

I shall now proceed with the various Plantations in the order in which they are most conveniently visited, merely premising that, although none of them forms an extensive tract, they present in the aggregate, a triumph of arboricultural skill such as is but rarely seen in this country.

No. 1.—*The Burning Mountain*, in the parish of Trimingham, containing four acres. Stands 290 feet above the level of the sea, from which it is distant a quarter of a mile. The soil is a miserable sand resting on gravel. The surface was trenched about 18 inches deep, and planted in 1840 with two years' seedling fir, larch, oak, chestnut, alder, birch, and hazel from Scotland. The plants were placed at from 2½ feet to 3 feet apart, it being indispensable in this situation to have them so close at first as in some measure to shelter one another. The space between the plants was hoed for three years, and then the plants were left to themselves. The larches and birches are now six feet high. The oak, hazel, alder, and Spanish chestnut, are remarkably healthy, and the general character of the plantation is almost as thriving as if it was inland and well sheltered.

No. 2.—*Longs Hill*, in the parish of Trimingham, containing from nine to ten acres. Stands 300 feet above the sea, from which it is about the same distance as the foregoing. Naturally, the surface soil, to the depth of four inches, was composed of peat and gravel, resting on a solid bed of the latter, from which materials for making and mending the roads in the neighbourhood have been taken. The trenching to the depth of 18 inches has mixed the soil, so that the surface now presents the usual appearance of the poorest description of land. From two acres

of the worst of it, 200 loads of large stones were removed. This hill was planted in 1844 with a mixture of Scotch pine, larch, and hardwood trees. A part of the hill, containing about an acre and a half, was sown with white Belgian carrots, and the produce from this space was 820 bushels. The trees and shrubs already distinguishing themselves by their healthy appearance are the mountain ash, birch, Scotch pine, the snowberry, and the berberis, *Mahonia aquifolium.*

No. 3.—*Ranny Plantation,* also in the parish of Trimingham, containing from four to five acres, and planted in 1842. This hill, previous to its being planted, was covered with short heath and furze bushes. The surface soil, composed of peat to the depth of three inches, rested upon a hard crust or pan of iron sand-stone, under which was, and still is, a deep bed of gravel. The oak, which was the tree Sir Thomas was most anxious to see flourishing in his plantations, remains here in abeyance until the others advance in height so as to shelter it; but in such spots as it is protected, it thrives well. In others, where it stands exposed to the winds, its top is killed. The sycamores on the top of the hill are remarkably healthy, not a branch being wanting in clusters of foliage; and around the base and in narrow gullies, sheltered a little from the wind, are hazels and alders already large enough to be used as hurdles, for which purpose many of them are to be cut down this season. Here the berberis, *Mahonia aquifolium,* forms a thick and rich undergrowth, and I think for sheltering game it is unrivalled by any other shrub. Its berries, which it bears in such profusion, are eaten by pheasants and partridges, and I have no doubt we shall soon see it planted extensively in preserves. But for the hoeing, this plantation would have been speedily overrun with the wild potentilla, one of the most persevering enemies to ligneous vegetation in its young state. After three years, the trees here have foliage dense enough to choke the weeds; but had they been planted at a greater distance apart, the expense of cleaning must have been prolonged for a season or two longer.

No. 4.—*Pond Plantation,* a small piece containing an acre and a half, in the same parish as the last, and planted in 1840. The soil is of poor sand lying on a hungry gravel. Its elevation is 250 feet above the level of the ocean, from which it is distant nearly a quarter of a mile, its aspect being to the north. Like the others, it was trenched to the depth of 18 inches, and the plants placed at about 2½ to 3 feet apart. The alders here are 7 feet high, and the poplars 10 feet: many of the latter have been cut down as hurdle wood. The English oaks are sufficiently thick in this plantation to form a crop, and in a few years more they are intended to be the sole occupants of the soil. The Scotch elm,

Ulmus montana, here proves itself to be a suitable plant to grow on maritime situations like the present.

No. 5.—*Nut Copse,* in the parish of Trimingham, partly planted in 1840 and partly in 1842. Its extent is three acres, its altitude 200 feet above the sea, lying about half a mile distant from the cliffs, with a southern aspect. Here the soil varies considerably, some of it being poor and stony, and in other parts a rich clay being found to a great depth. The trees are vigorous in the extreme, some of the larches having made shoots this season 18 inches in length. In this plantation the English and Levant oaks seem to have found a congenial soil, many specimens planted in 1840 being now 10 feet in height. In the lower parts, oziers are grown, which are sold to the basket-makers at the rate of L.10 per acre.

No. 6.—*Boreas Plantation, eight yards* from the cliff which is washed by the German Ocean—the boldest trial which has been made in this part of the country. The plantation runs alongside the brink of the cliff, which is 250 feet high, and includes the watch-house of the Preventive Service. The height will of course indicate the altitude of part of the planting above the level of the sea, but the remainder, on the top of the hill, may be reckoned at an additional 100 feet. The exposure is to the north-west, and the keen and biting air to which the trees are subjected may be easily fancied from their close proximity to the beach. From this plantation, the beholder looks down upon a wide expanse of the ocean, which is here often whitened by the sails of the Scotch and Baltic traders; and it is not difficult to picture how still more charming the view must be when it can be enjoyed, as here it will be in a few years more, from the shelter of a sylvan bower. This piece contains eight acres, and is in the same parish as the others. The soil on the surface is a mixture of sand and peat superincumbent on a mass of clay, which, judging from the nature of the exposed cliff, extends to the depth of more than 100 feet. Underneath, is an irregular mixture of different strata, composed of clay, sand, and chalk boulders, thrown into various contortions, owing no doubt to some lateral pressure. The soil was trenched in the same way as the others, and the planting was proceeded with in the spring of 1842. The proprietor was strongly recommended to try upon this piece a collection of trees differing from the others, so that here we have Pinus Pinaster, P. maritima, P. austriaca, P. Mugho, the sallow, ozier, elder, alder, ash, and sycamore in abundance. Towards the sea, along the edge of the cliff, a close substantial fence was erected of furze and brushwood to the height of about six feet. Next to it are planted the alder, ozier, and sallow, intermixed with the Pinus Pinaster, and the Pinus

Pinaster minor, or, as it is sometimes called, the P. maritima minor: the latter trees are both six feet high, the present year's shoots being in some cases fifteen inches in length. From the present appearance of these pinasters I could not discern any difference in their rate of growth; and as they have been only four years in their present situation, it would be premature to found an opinion of their relative merits for maritime situations, even if such a disparity could be detected. In the succeeding pages of this Report ample evidence will be found of the fitness of both trees for such bleak and barren tracts *as the Scotch pine even is unfitted for*—the largest plantation of pinasters in Britain being only a few miles distant from those under review, and occupying the worst possible description of land. I was particularly struck with the appearance which the common ash-tree presented in the Boreas plantation; for the prevailing belief is that it is easily hurt either by frost or exposure; this, however, I believe to be applicable only to its foliage, and my opinion is, that it is one of the few hard-wood trees suited for growing near to the sea. Several of the specimens are now 18 inches above the fence-line, so that their tops are continually acted upon by the sea-breeze. I make this statement with the more confidence from having seen large ash-trees growing in the parish of East Runton, about half a mile from the cliffs, one in particular growing in front of a garden belonging to Mr Moy, farmer, measuring 9 feet in circumference at 2 feet from the ground.

No. 7.—*Hulvey Hill*, containing five acres, planted in 1840 with oaks, larches, alders, Scotch pines, &c. The aspect of this hill is chiefly towards the north-west, and its altitude is 240 feet above the sea, from which it is distant half a mile. All the trees are in a thriving condition, but the alders have made better growths than the others, and are to be cut down this season to make room for the more valuable hard-wood trees.

No. 8.—*Rome Plantation*, so named from its being planted when the present proprietor, Sir Edward North Buxton, was at Rome in 1840. It contains five acres, and is similarly situated to the foregoing. An improvement is yearly observable in the fields adjoining, from the warmth and shelter already afforded by the trees. Here, again, the alder is taking the lead; and it is worthy of especial remark, that this tree, which is generally consigned to wet and boggy lands, prospers remarkably well on poor sand and peat on the most exposed places. Such a fact, I am aware, will not be found in our books of arboriculture, for, until now, little or no effort has been made to extend the dominion of trees, and of course the old limits of the "swamp and bog" have been reiterated as bounding the services of this most useful tree. The trenching of the soil will be the means of adapting many trees for

the mountain-tops, which otherwise would be as unfit for such a situation as some of our half-hardy exotics.

No. 9.—*Broom Hill*, in the parish of East Runton. This piece contains four acres, and was planted in 1841. The soil is a sandy gravel on a subsoil of pure gravel. Towards the north-west, facing the sea, the alder, spruce, and birch thrive best; and, on the south, the evergreen oaks, poplars, Spanish chestnut, and Mugho pines, are uninjured. This hill is about 180 yards from the sea, and it is a remarkable fact that the evergreen oaks in this plantation were not at all injured by the severe frosts in the beginning of the present year (1845;) whilst those in inland situations, well sheltered, were in many cases completely cut off. The Pinus Mugho is here three feet in height. A crop of carrots was taken from this hill during the first season of its being planted.

No. 10.—*Sand Hill*, containing three acres, and adjoining the former; planted in 1841. This hill is very much exposed to the north-west, or the sea-side. The surface is of miserable sandy soil, resting on red iron sandstone, and is justly considered to be the worst soil in the parish of Runton. The sallow and alder have been the means of enabling the oaks and other hard-wood trees here to establish themselves; and they are now being cut out to make way for a permanent crop of timber. It would have been impossible to have raised valuable hard-wood trees here without the aid of the soft-wooded ones just alluded to; and the plan has been invariably to let the former remain for at least three years under shelter of the latter, and then to expose them gradually to the climate. The sallow makes excellent wicker hurdles; and the alder for faggot-wood, made up in bundles from three to four feet in circumference, is sold at the rate of 10s. per 100 of six scores. This hill is 150 yards from the cliff, and 200 feet above the sea.

Nos. 11 and 12.—*Gurney Plantation* and *Marl-Pit Plantation*, 300 yards from the sea, and 230 feet above it. These, together, occupy only two acres. The former is named in compliment to the eminent London banker and bill-broker. The Marl-pit piece is fenced in with old barrel-staves, from the brewery of Truman, Hanbury, Buxton and Co., Spitalfields, which give it a particularly neat appearance. Here, again, the sallow and alder are taking the lead; and on a slope facing the sea, *behind* these trees, the oak is flourishing well. The sallows, planted in 1842, are already ten feet high.

No. 13.—*Portland Pit*, containing three acres, and planted in April 1841. The altitude of this plantation is not above 150 feet, and it is distant about half a mile from the sea. Though facing the north, the sea-breezes are intercepted on their way to it by higher hills along the sea-coast; and the consequence is,

that oaks, larches, and Scotch pines, are equally thriving, many of the first-mentioned trees being ten feet high. The soil is of a loamy gravel, and appears to be favourable to the growth of all kinds of trees.

No. 14.—*Fernando Plantation*, made in 1841, and containing six acres. It stands away a considerable distance from the sea-side, and is consequently devoid of that interest attached to the others.

No. 15.—*Niger Plantation*, in the parish of Runton, planted in the spring of 1841, and containing ten acres. The soil here is variable, but it is chiefly of sandy loam resting on marl. The top of the hill is reckoned 500 feet above the level of the sea, and here the trees are confined to the Scotch pine, larch, and birch. This plantation is distant from the sea-side nearly half a mile, its aspect being towards the ocean. It assumes more than any of the others the character of an ornamental piece of planting, being skirted with laburnums and purple beeches. It was often resorted to by the late Sir Thomas Fowell Buxton. I measured some of the larches and oaks at the base of the hill, and found them to be fourteen feet high. Several acres of this piece might be selected, at least equal to any inland plantation in the county of Norfolk.

No. 16.—*Edward's Plantation*, made in 1843, containing fourteen acres, of a rough surface, forming an irregular amphitheatre, facing the sea. Its altitude is from 350 to 400 feet, and it stands at a similar distance from the beach as the foregoing. The soil is sandy on a deep bed of gravel. Here the pinaster has been planted extensively, and is already promising to afford, at no distant day, the advantages usually derived from its massive shelter. It is intended to be cherished along with the oak till of full maturity. The berberis, already alluded to, thrives very well in this plantation.

No. 17.—*Earlham Plantation*, fourteen acres, lying near to the previous one, but having been made so recently as 1844, affording no particular points for remark. The Araucaria imbricata, and the Pinus excelsa, are profusely intermixed with the other trees, and as yet they are looking well.

No. 18.—*Fair Lady Plantation*, eight acres, planted in the spring of the present year, (1845,) and fenced with barrel-staves from the Spitalfields' brewery.

Nos. 19, 20, 21.—*Congham Hill, Spratts' Hill, and Little Soudan Hill*, containing together about five acres. These are small eminences lying along the sea-coast, characteristic of the prevailing scenery in this quarter. They contain only miserable soil, too poor to be operated upon by the agriculturist. The osier, sallow, and alder act as nurses to the hard-wood trees throughout those pieces.

No. 22.—*Davie Hill*, 300 feet above the sea, and lying nearly half a mile distant from it. Its extent is eight acres, and the soil is various—much of it of pure sand. This plantation was made in the spring of 1841, during the last fortnight in March, and, by way of experiment, several acres were planted on *untrenched* soil. The result was, that about two-thirds of the plants died—thus affording a practical proof of the necessity of carefully preparing the soil previous to planting. Another experiment was here made—that of inserting large plants, four to five feet high, instead of smaller ones of two or three years' growth. This also proved a failure, the greater part of them being unable to establish themselves. The farmers in the neighbourhood are beginning already to appreciate the advantages their lands and stock derive from the yearly increase of shelter afforded by this and the neighbouring plantations.

Such are the details of a series of plantations made under the most unfavourable circumstances—many of them on the very banks or bulwarks of the German ocean—a tract for thousands of years unmarked by any feature of fertility, but now in the course of bearing the richest covering which the earth displays. With regard to them *all*, I am safe to say that not an acre has been planted worth renting for agricultural purposes; for the farmer who had one of the best pieces, said—"He should not put his plough into it again."

The lessons taught by the state of these plantations are numerous; and as these are the chief objects and use of the present Report, it will be permitted me to ask the most pointed attention to the following observations, which, if strictly attended to, cannot fail to be of essential service to all who intend planting in maritime situations:—

1. *Preparation of the Soil.*—Nature, and more especially unassisted nature, does but little to tempt man to plant by the sea-side: it is a union of the wild and tame, which, though permitting, she will not foster. Hence we never see trees spontaneously arise in such places. Art, therefore, must go to the fullest length of her resources in preparing the soil. It consequently follows, that all maritime planting, to be done effectually, must be an expensive process; and the chief item in this expense is *the trenching of the land.* Without this preliminary step, the land had better remain as it is; for a plant which cannot readily establish itself underneath, cannot stand the buffeting of the the tempestuous and keen-edged winds off the boundless ocean.

2. *Time for Planting.*—In maritime places, the young trees should be invariably planted in the spring, just immediately before that time when the plants begin to grow. The next best time is the last week in October. But though those trees planted early in autumn furnish themselves with small roots or tender spongioles previous to winter, these are not sufficient to support the trees in such situations during the most trying months, so that it is infinitely better to let them have the benefit of a full season's growth before the effects of winter are felt by them in their new situations. The last week in March, or first week in April, is a suitable time to plant in such places. Planting in winter months has been tried repeatedly in the neighbourhood, but with no success.
3. *Choice of Plants.*—Experience proves that, for the particular situation under consideration, such plants as are two or three years' old are better than any others; and such as had been transplanted in the nursery the year previous, are to be preferred to those which had remained for two seasons.
4. *Shelter.*—However well the land may be prepared, and the season chosen for planting the young trees, *shelter* is indispensable, both as an outwork, or round the outside, as well as an immediate agent in ameliorating the climate around each tree. The best external fence between the young plantation and the sea, is furze bundles, or brushwood cut in summer-time, with the leaves on the branches; or failing these, a turf wall, very broad at bottom, and tapering to the top. The best sheltering nurses, amongst deciduous trees, are the sallow, alder, osier, and birch; and amongst evergreens, the Scotch pine; but as these nurses would be gladly accepted in many instances as permanent occupants, I would earnestly recommend them as particularly fitted for such situations. Oaks, and the finer kinds of pines, should be surrounded with the nurses, and particularly protected by them on the side next the sea; but, in ordinary cases, it is sufficient to plant them mixed with the nurses, so that the young trees may protect each other in a general way.
5. *Cleaning.*—The hoeing of the land for at least two years is all-important, and if a crop of carrots is taken from the ground the first year, as has been practised here, they will help to keep down the weeds, and pay the expenses for plants, cleaning, fencing, &c.

Another important species of information is afforded by these

plantations, by their indicating the kinds of trees best suited for braving the sea-breeze; and here I must observe, that, although long conversant with planting under every variety of circumstance, I was surprised and delighted to find that a tree which I had never recommended for such situations is, beyond all others, entitled to take the lead, as the best adapted to grow in exposed maritime tracts. I therefore give it the preference in the annexed list, earnestly urging all those who have lands by the sea-side to give it a trial.

1. *The Common Black Sallow or Goat Willow,* (Salix Caprea.) —It was the wish of the late Sir Thomas Fowell Buxton that the most of the trees planted on his estates in this quarter should give place to the English oak; so that the sallow was grown here merely for the sake of creating shelter, in which capacity it is certainly without a rival amongst deciduous trees. But, though here used only as a nurse to the oak, it is fortunate that this willow has claims upon the attention of the planter as an independent object. Its claims, however, appear to be entirely hid from planters; for writers on trees, I find, refer to it continually under the character of an undergrowth, affording "excellent hurdles, and good handles for hatchets," and as used in the manufacture of gunpowder, &c. Now, the fact is, that though it is, almost without exception, kept down as an undergrowth, and used for fences and hurdles, it is capable of becoming a great tree, most singularly and beautifully clad in spring-time with handsome silken blossoms. On Mr Moy's farm, East Runton, about three-quarters of a mile from the sea, is a specimen, with a trunk which, at 4 feet from the ground, is 9½ feet in circumference—thus proving that the tree not only grows to a large size, but that it does so in the neighbourhood of the sea.
2. *The Alder, Birch, and Osier.*—Those three have here proved themelves to be admirably fitted for sheltering the oak and other valuable trees; and, in every plantation made in an exposed situation, I would recommend them to be planted not only as nurses, but as permanent occupants of the soil.
3. *The Ash, Sycamore, and Elm,* (Ulmus Montana.)—The ash is too well known to require any description here. I refer to it merely as having displayed itself to great advantage in the most exposed situation here described, viz. in the Boreas plantation, and as having attained to a large size within half-a-mile of the ocean at Runton. From such

evidence, I have no hesitation in urging its more general introduction in tracts lying adjacent to the sea. The second tree has been long known as a plant adapted for maritime sites, and its appearance here fully justifies the distinctive character thus assigned to it. The elm, I expect, will become a noble addition to the few trees suited for tracts of country similar to that under consideration. Generally, this tree becomes bark-bound and covered with lichen when planted near to the sea in *untrenched* soil; but where it is free under its roots, I find that it soon surmounts the difficulties of establishing itself, and pushes vigorously.

4. *Pinasters, two varieties, Pinus Pinaster, and P. P. Minor.*— These trees have been planted in considerable numbers here, and, so far as can be judged from their present appearance, they are likely to reach the size of timber trees in a very short time, their growth in this situation being very rapid. No doubt, however, can arise of their perfect adaptation to the bleakest part of the country, and the poorest description of land; for, on the Westwick estate, a few miles distant from the Trimingham and Runton plantations, a continuous tract of them is to be found, covering a space of upwards of 500 acres in extent, and traversed by a carriage-road five miles in length. A short digression, detailing some particulars connected with these woods, will, I am sure, be pardoned in this Report, especially as information is particulary requested regarding this tree.

The soil on which this extensive plantation stands is a dead reddish sand, on a subsoil of gravel, and, in some instances, there is a great depth of pure sand only, not very much better than that usually found along the sea-beach. The site is exceedingly exposed on all hands; its aspect, generally, being towards the north-west. The first trees of this species were planted in 1702, by John Berney, Esq., who was then proprietor of Westwick; and it appears that the eldest daughter of that gentleman married William Petre, Esq. of Newhouse, Essex, who thus succeeded to the estate. The issue of this marriage was the celebrated planter, the late John Berney Petre, Esq., who raised several hundred thousand plants from his own trees, and planted them as above detailed. The common pinaster is here called the *true* pine, and the P. P. Minor the *false* pine, the greater proportion of the trees being of the former. As to the quality of the wood, the forester informs me that he can discover no difference. The *Minor* appears to be a denser or more compact tree than the

other, carrying with it a greater bulk of stem in proportion to its height, the leaves being shorter and less upright, and the cones smaller than in the other tree. The young buds of the common pinaster, on the top of the trees, and chief side-shoots, are at the present time (October) of a light-brown colour, whilst those of the *Minor* are almost invariably covered with resinous exudations, which impart to them a whitish colour. If this resinous coating be a permanent characteristic of the variety, there is little doubt of its being hardier than the other, as the matter so incrusted shields the buds from the effects of intense cold.

J. B. Petre, Esq., in communicating information regarding these plantations to the "Society for the Encouragement of Arts," &c., thus writes in 1809:—"Having been a planter of firs and forest trees for more than fifty years upon a large scale, my friends have often solicited me to lay the particulars before your Society, as few in the kingdom have exceeded me in this pursuit. I am at length induced to lay my labours before you in the following statement:—About 30 years ago, I planted in my park, and on the heath adjoining, about 200 acres with different trees; the soil of the latter was so poor that the Scotch firs, which I chiefly appropriated to that place, died after having been planted 15 years, owing to the poverty of the soil and their exposed situation. The pinaster, or cluster pine, has always been a favourite tree with me for the beauty of its foliage and goodness of the timber. I have in my groves, I believe, some of the finest in the kingdom, estimated by Mr Nathaniel Kent, of Craig's Court, a member of your Society, as containing five loads of timber in a tree, and upwards of 80 feet high; it therefore occurred to me to raise some young plants from them, and when these plants were 2 years old, I filled up with these young pinasters the vacancies occasioned by the death of the Scotch firs; and though planted 16 years after them, they are now by far the largest and handsomest trees. Upon observing the rapid growth of these trees, I was induced to enlarge my plantations, and took into my park 200 acres more, which I planted entirely with pinasters, except in the valleys where other trees grew. My pinaster plants were all raised from my own seed; and this year their progress has been astonishing, and they are the admiration of all persons who have seen them. I am preparing to add another 100 acres, and I have raised above 200,000 plants for that purpose. I shall then have a plantation of 500 acres, with a five-mile drive through it."

With reference to the same tree, Mr Petre, in another communication to the same Society in 1810, observes—"As to soil, they will grow on any. I have plants that have made shoots of 5 feet in two years, where the soil is a bleak heathy sand at top,

and gets down either to a hard stony gravel, or a dead yellow sand; and where they are planted on the declivity of a hill, I have seen the main roots so flat that they have come out of the surface, and struck in again two or three feet down the hill, if steep. Having been in the habit of planting pinasters for upwards of 40 years, you may justly presume I have them of all sizes. The trees on the above-mentioned poor soil have been planted about 9 years; they measure from 10 to 20 inches round, and I have many in my older plantations that measure from 3 to 4 feet round, and their height upwards of 40 feet. . . . Those pinasters which Mr Kent estimated at near 5 loads were planted in 1702. The largest are about 10 feet in circumference three feet above the ground, and they diminish very gradually till they get near the top."

These extracts contain cheering information to proprietors of the poorest soil. It has been generally understood that the Scotch pine is, of all trees, the least scrupulous as to the quality of the land it may be placed in; but we have a proof here that another individual of the cone-bearing family, is even more serviceable in sheltering bleak and barren districts. As might be expected, the older specimens of the pinaster upon this estate are now of very noble character. They average 12 feet in circumference, and 70 feet in height, forming by far the finest collection of this species of tree in this country. They are intermixed here with broad-leaved trees around the house, and add a boldness to the scene which the latter of themselves never confer. Where this pine prevails in its grandest form, the feeling awakened is that we are in the neighbourhood of tremendous rocks and crags; but the general reader must see the bulk and majesty of these objects to prepare him for this idea.

5. *Underwood Shrubs. The Snowberry and Berberis,* (Symphoricarpos racemosus, and Berberis Aquifolium.)—The plantations of Trimingham and Runton display a profusion of these shrubs growing most vigorously; and I can have no hesitation in stating that they are well adapted to grow along with other trees near to the sea-side. Their merits may be summed up in a few words. They are both eminently beautiful; the former, when clad with its pure white berries from September to December, and the latter, throughout the entire year. This plant (the Berberis) is furnished with pinnate, shining, holly-like leaves, and bears beautiful racemes of yellow flowers, which are succeeded by grape-coloured or bluish-purple berries, in great profusion. Though so unlike to each other in appearance, there is a remarkable affinity subsisting between those shrubs, which points them out as the fittest of companions:

they fear not the sea-breeze, a fact which might have been anticipated from their being both natives of the north-west coast of America, from New Albion to Nootka Sound; both plants, when in blossom, are much sought after by bees; and the berries of both are greedily eaten by game. The delightful uses to which such plants may be applied will suggest themselves to every one; and it is only necessary to remark that they are best suited for being planted close to walks, which should be introduced in all maritime plantations, for the sake of the view over the ocean.

It will be remembered that the remarks here made have a constant reference to trees and shrubs planted in *trenched* ground: I know of no trees which will grow vigorously by the sea-side in cases where the roots of the young plant have not the readiest access to the soil.

I have found some difficulty in preparing a statement of the *expense* of forming the plantations here described. For its accuracy in minute details I dare not vouch, as some of the finer kinds of pines, &c., such as the deodars, were presented to the late proprietor by his friends; and in other cases, though few, the plantations are ornamented with the more expensive kinds of rhododendron, &c., the bills for which I have not had an opportunity of examining. Apart, therefore, from what may be termed the ornamental decorations, which are not essential to the full crop of thriving trees now growing in the two parishes, the account may be made up with a satisfactory approach to accuracy. The whole extent planted is 117 acres, all of which was trenched, with the exception of about 3 acres on Davie Hill, left for the purpose of ascertaining what progress trees would make in unprepared land. The account being made up so soon after the planting of the trees, will prevent, of course, any return being stated for the usual source of profit in a plantation—that of timber; and indeed the chief proceeds from the sale of faggot-wood, which sells well in this quarter, will fall in years yet to come; so that the statement of outlay, like all statements made under similar circumstances, is to be counterbalanced by the certain profits awaiting the present proprietor at a future period. At same time, it is to be borne in mind that mere remuneration for outlay is not always, or even often, the object reckoned upon in maritime planting; and, in the present instance, I may safely say, that the chief motive of the distinguished individual under whose directions those plantations were made, was the sheltering and beautifying a tract of country which commands one of the finest sea-views in this kingdom. They are to be looked to, therefore, as a triumph of art, and not solely as the means of bringing back a certain capital expended with a fair rate of interest, though even in this respect the result is favourable.

THE TRIMINGHAM AND RUNTON PLANTATIONS.

DR.	L.	s.	d.
To trenching the land 18 inches deep—114 acres, at L 6 per acre, - - - - - -	L.684	0	0
— carting stones from the land, - - -	15	10	0
— erecting fences, gates, &c. - - -	158	0	0
— 600,000 plants, at 10s. per 1000, including the expense of planting, - - - - -	300	0	0
— 80,000 plants, at 15s. per 1000, do. do., -	60	0	0
— hoeing to October 1845, - - - -	102	12	0
— bill for carrot and parsnep seed, - -	17	12	0
	L.1337	14	0

CR.	L.	s.	d.
By sale of osiers, - - - - - - -	L.31	0	0
— 5720 bushels carrots and parsneps, raised at Trimingham from 1841 to 1844 inclusive, at 7½d. per bushel, - - - -	178	15	0
— 5300 bushels carrots, raised in Runton plantations from 1841 to 1844, at 7½d., - -	165	12	6
— present year's crop estimated at 1500 bushels, at 7½d., - - - - - - -	46	17	6
— carrot-seed sold in 1842, - - - - -	30	7	0
— sales of hurdle-wood and fagots, - -	25	10	0
	L.481	2	0
By balance, - - - -	856	12	0
	L.1337	14	0

It will be borne in mind, that a carrot and parsnep crop can only be had from the land occupied by the plantations, *for the first two years only;* but that as soon as this source of profit fails, a regular return commences from the sale of fagot and hurdle-wood.

I am informed that including all the finer kinds of pines here planted, and the valuable shrubs, would increase the expense at about ten shillings an acre over all the plantations; so that the account, including every thing, would stand thus:—

The Trimingham and Runton Plantations.

Dr.		Cr.	
To expenses as before stated, . .	L.1337 14 0	By Return, as above stated, . .	L.481 2 0
- - Additional for pines, cedars, roses, rhododendrons, and other fine shrubs, .	57 0 0	— Balance, . .	913 12 0
	L.1394 14 0		L.1394 14 0

It will be gratifying to many to know, that the latter years of the distinguished philanthropist whose plantations I have described in the preceding pages, were spent chiefly in his usual works of benevolence, *and in watching the progress of his trees*;— thus affording another illustration to the generally received opinion, that the greatest and best of men, in all ages, have found a peculiar satisfaction in the peaceful and healthful pursuits of planting. It is gratifying that he was enabled, before his death, to see the fruits of his enterprise in the flourishing plantations which he had formed.

PROCEEDINGS OF THE AGRICULTURAL CHEMISTRY ASSOCIATION.

XXX.—*Composition of Limestones from Argyleshire, Berwickshire, and Sutherland.*

1°. *Limestones from Argyleshire.*

a. From Ardgour upon Loch Eil.—Among the so-called gneiss or oldest slate rocks of Inverness and Argyle, there occur, among the highly inclined strata, beds of limestone more or less crystalline, many of which are of sufficient thickness to be worked, and in localities in which the use of lime would be a prelude to much agricultural improvement.

A bed of this kind runs along the face of the hills on the Ardgour side of Loch Eil, in a northerly direction, from the Corran ferry to an unknown distance. It is in the form of a bed of eight or ten feet, and sometimes considerably more in thickness, and lies at a very high angle. Some of it is almost pure white and semi-crystalline. It is mixed with a variable proportion of fragments of quartz, which form distinct prominences on the surface of the rock, where it has been exposed to the action of the weather. I have found this quartz, upon analysis, to vary from 6 to as much as 80 per cent of the whole. The more siliceous portions, however, are not difficult to distinguish, and in quarrying could easily be rejected.

During a late visit to the spot, I collected specimens from two different localities upwards of a mile apart, and, upon analysis, they have been found to possess the following composition—

	No. 1.	No. 2.
Carbonate of lime,	90 14	89.15
Carbonate of magnesia,	0 31	2.56
Alumina and oxide of iron,	0 51	0 51
Insoluble siliceous matter	9 08	7.48
	100.04	99 70

They are both very good limestones, therefore, and might be employed for agricultural purposes in the district with much advantage. One of the localities is situated near a waterfall, where ample power could be obtained for crushing it. The neighbourhood of the island of Lismore, however, which abounds in lime, and of Loch Leven, on the northern shores of which thick beds of limestone form cliffs along the road, will probably prevent this Ardgour lime from ever being extensively worked.

In the higher or more inland part of the country, to which transport is difficult, it may be found profitable to work it for local consumption.

b. Limestones from Cantyre.—The district of Cantyre is a very interesting one, both agriculturally and geologically. The low oolite flat called the Laggan, stretching across from Campbelton to the Western Sea, rich in coal below, and capable of great agricultural improvement on the surface — the spirited and thriving race of farmers who have lately settled in the country, and now hold a large portion of its surface—the gradual change for the better now going on, both in the husbandry of the district and in the condition and habits of the people—all these circumstances render this district very interesting to those who are occupied with agricultural pursuits.

It is fortunate for this district that it is rich in lime. Besides

the deposits of limestone marked on our geological maps, as lying on the north side of Campbelton bay, others exist in large quantity to the south and west, at the distance of four or five miles from Campbelton. I had not an opportunity of examining accurately the geological position of the thick bed, which is most extensively worked; but, from its appearance at a distance, I judged it to be one of the highly inclined beds of the slate rocks. The comparative proximity of the oolite and old red sandstone rocks, however, renders this point worthy of further investigation.

The limestone is of a yellowish colour, and has the following composition—

Carbonate of lime,	98.05
Carbonate of magnesia,	0.44
Alumina and oxide of iron,	0.29
Insoluble matter,	1.27
	100 05

It will yield, therefore, a very good agricultural lime.

On the west coast, a mile or two above Ban—a district in which great agricultural improvement is attainable—I met with a vein of black crystallised limestone, of a few feet in thickness, *crossing* the slate rocks, and which had the following composition—

Carbonate of lime,	90 96
Carbonate of magnesia,	0 62
Alumina and oxide of iron,	1.81
Insoluble matter,	6 40
	99.79

This is also a very good limestone for agricultural purposes; but the vein is too thin to admit either of profitable or extensive working. Towards the interior of the country, thicker beds of limestone may probably be discovered, which may hereafter be made available when passable roads shall have been constructed across the peninsula.

On the south-east coast, near the mouth of Glenharvie, I found upon the shore a thin vein of very hard pale-yellow crystalline limestone, traversing the old red sandstone beds, too trifling to be turned to any agricultural use, but which, for other reasons, I have thought it interesting to subject to analysis. It was found to consist of—

Carbonate of lime,	46 33
Carbonate of magnesia,	29 68
Alumina and oxide of iron,	11 64
Insoluble siliceous matter,	11 95
	99.60

It appears thus to be very rich in magnesia, a circumstance not unimportant when taken in connexion with the composition of the limestone beds, found among those of the old red sandstone in Berwickshire, of which the analysis is given below.

2°. *Limestones from Berwickshire.*

In the higher part of Berwickshire, which stretches from Dunse towards Greenlaw, there crop out in the bottoms of the burns and on the sides of the hills, numerous thin beds of limestone among the shales, red marls, and sandstones of the old red rocks of the district. These have occasionally been quarried and burned for lime. Having lately visited several of the localities where this limestone occurred, I thought it of some interest to determine their composition, not only in reference to their agricultural value, but also with the view of determining how far their geological position might affect the proportion of magnesia they contained.

For this purpose, Lord Breadalbane was kind enough to send me four specimens for analysis, collected on various parts of his property of Langton, near Dunse. These specimens were found to have the following composition:—

	No. 1. From washing pool, Langton Park.	No. 2. From the part of Langton wood where some of the stone had been burned.	No. 3. From an old quarry, supposed the same where a stone was got which was burned for lime.	No. 4. From Greueldykes, on the east of the Langton estate.
Carbonate of lime	43.85	47.00	39.01	43.81
Carbonate of magnesia	33.34	38.04	30.25	39.50
Alumina and oxide of iron	1 59	1 99	1.39	3.57
Insoluble siliceous matter	21.41	12.97	29.27	13.09
	100 19	100 00	99 91	99.97

The limestones are all remarkable for the large quantity of magnesia they contain. Should they even be quarried extensively for burning, they will make an excellent building, but an inferior agricultural lime, and must be laid sparingly upon the land.

The limestones from the slate and gneiss rocks, of which the analyses are given above, and of which many others have been analysed in the laboratory of the Association, are all comparatively pure, contain at least little magnesia. Those from the old red sandstone, on the other hand, abound in magnesia. Are these universal characteristics of these rocks, or are they merely

local phenomena? I should be obliged to any of the members of the Association for specimens of limestones from the old red sandstone of other counties, the analysis of which might throw further light upon this interesting point.

3°. *Limestones of Sutherland.*

The composition of a marl from Assynt, in Sutherland, has probably some connexion with the above question.

In the district of Assynt, towards the western coast of Sutherland, there occur rocks or beds of limestone of considerable extent, though not marked on our geological maps. A marl found in considerable quantity at the foot of a limestone rock in one of the glens of Assynt, was lately sent to the laboratory for examination. Upon analysis, it was found to consist of—

Alkaline salts,	0.20
Gypsum,	0.27
Carbonate of lime,	49.92
Carbonate of magnesia,	36.23
Oxide of iron and alumina,	4.70
Insoluble siliceous matter,	7.92
	99.24

When examined under the microscope, it appeared to be made up in great part of minute rhomboidal crystals, and was probably, therefore, derived from a crystalline limestone, crumbled by the action of the weather.

This district in our geological maps is included in the gneiss country. If the above limestone, therefore, be in this geological position, it settles the question as to the universal freedom from any large admixture of magnesia in the limestones which occur among the gneiss rocks of Scotland—for the proportion of magnesia, as the analysis shows, was very large. It was about equal to what was found in the limestones of the old red sandstone of Berwickshire.

But we know that metamorphic or changed rocks, like those of the Scotch gneiss, may be of any age. In the wide area occupied by this class of rocks in Scotland, we may have many subdivisions, some of which may be characterised by pure, and others by dolomitic or magnesian limestones. Chemical analysis, therefore, may aid the geological observer, as well as the agriculturist, by indicating to the one where rocks of a particular age may be looked for, and to the other, where limestones of this or that agricultural value are to be expected.

It is possible that the proximity of the old red sandstone rocks,

which skirt so much of the west coast of Scotland, may be connected with the large proportion of magnesia in the limestone of Assynt.

XXXI.—*Composition of the Sludge of the river Urr in Kirkcudbright.*

The tide of the Solway Frith makes its way for many miles up the river Urr in Kirkcudbright, and, as it ebbs, leaves deep banks of mud or sludge on either side of its channel. This mud is, of course, chiefly derived from the debris of the rocks and soils of the upper country from which the waters of the river come—and which, when dammed back by the tide, they quietly deposit.

When the river passes the house of Mr Maxwell of Munches it leaves such a deposit, and as a considerable tract of reclaimed moss land lies near its banks, it occurred to Mr Maxwell that the sludge of the river might form a useful application to its surface. But as he had hills of gravelly soil also which were equally accessible, and had already been employed to a considerable extent for this purpose, he was desirous of ascertaining which of the two would be likely to produce the better effect. He sent therefore to the laboratory two samples of the sludge, one taken recently from the river, and another which had lain some time on its banks, and along with them a portion of the gravelly soil, with a view to a comparative analysis of the two being made. They were accordingly subjected to analysis, and the following results obtained:—

	Gravelly soil	Sludge, No 1.	Sludge, No. 2.
1st. By Washing.			
Clay, fine sand, and organic matter,	28.80	19.60	26.00
Coarser sand, ...	71.20	80.40	74.00
	100.00	100.00	100.00
2d. By Analysis.			
Organic matter, ...	1.91	2.78	2.92
Alkaline salts, (soluble in water and acids,)	0.76	0.26	0.80
Gypsum, (sulphate of lime,) . .	trace	0.37	0.32
Alumina, (soluble in acids,) . .	3.42	2.09	1.65
Oxide of iron, ...	4.75	3.78	3.48
Carbonate of lime, ...	0.60	7.17	6.86
Carbonate of magnesia, . . .	2.59	0.56	1.82
Insoluble siliceous matter, . .	85.76	83.18	81.68
	99.79	100.19	99.48

The sample of gravelly soil contained 66 per cent of large stones, varying from the size of a walnut to that of a pea.

These consisted chiefly of pieces of granite, felspar, and trap. These stones were taken out, and only the fine part of the soil was analysed and found to have the composition above given.

From these analyses it appears that a marked difference between the two exists in regard to the proportion of lime they severally contain. The seven per cent of carbonate of lime present in the mud of the river, as well as the minute division of its particles, gives it a decided preference over the other material as an application to moss land—upon which lime is almost a necessary of healthy and luxuriant vegetable life.

It is probable that there are many other places on the banks of the same river, and of the other rivers of the south of Scotland, to which it might be profitable to apply this tidal mud.

A question we are much inclined to ask is, where does all the lime this mud contains come from? The slate country through which the river Urr chiefly flows is not known to be rich in limestone; and yet the composition of the mud seems to indicate that deposits of limestone of considerable extent somewhere prevail. They may be too poor or impure to be profitably worked for agricultural purposes, and yet it might be of consequence to some of the proprietors in the upper country to institute a search for them, and ascertain their quality.

XXXII.—*Of the Composition of Pigeon's Dung.*

A novel article of import having recently appeared in the English manure market under the name of pigeon's dung, from Egypt, a sample of it was sent to the laboratory for analysis, with the view of determining its value, compared with Peruvian and the better varieties of Ichaboe guano. When subjected to analysis, it was found to consist of 23.9 per cent of soluble, and 76.1 per cent of insoluble matter. Its more detailed composition was as follows—

Water,	6 65
Organic matter, containing 3.27 per cent of nitrogen, equal to 3 96 of ammonia,	59 68
Ammonia,	1 50
Alkaline salts,	0 42
Phosphates of lime and magnesia,	7 96
Carbonate of lime,	2 37
Insoluble siliceous matter,	21 42
	100 00

It will be seen above, that the sample submitted to examination contained upwards of one-fifth of its weight of sand, a mix-

ture scarcely, perhaps, to be avoided in a country like Egypt. Had it been free from sand, its composition would have been—

Water,	8.46
Organic matter, containing 4.16 per cent of nitrogen, equal to 5.04 of ammonia,	75.94
Ammonia,	1.92
Alkaline salts,	0.53
Phosphates of lime and magnesia,	10.13
Carbonate of lime,	3.02
	100.00

As a manure, this pigeon's dung will be very valuable to the farmer, and if more free from sand, may prove even a profitable article of commerce. It is as rich in ammonia and ammoniacal matter as some of the best Ichaboe guanos. It is only half as rich, however, in bone earth; but this deficiency, if considered of importance in any particular locality, might be made up by an admixture of bone-dust, or of the waste bone charcoal of the sugar refiners.

XXXIII.—*Composition of the Refuse of the Glue Manufactory.*

Mr Girdwood, Corstorphine, one of our members, having been offered a quantity of the refuse of a glue manufactory for use as a manure upon his farm, brought a sample of it to the laboratory to be analysed, with the view of determining its composition, and the price he might safely pay for it. It was, therefore, submitted to analysis, and was found to consist of—

Water,	45.86
Hair,	1.10
Fatty matter,	22.34
Cellular tissue, and a little ammonia,	4.43
Phosphates of lime and magnesia, and a trace of iron,	2.30
Carbonate of lime,	20.06
Sand,	3.03
	99.92

The substance, therefore, was very valuable as a manure. With the exception of the water, which formed almost half its weight, nearly every thing it contained was of value in fertilizing the land. The skin, the hair, the fat, and the phosphates alone, independent of the carbonate of lime, were found, upon calculation, to be worth twice as much as the price asked for the whole by the manufacturer. The consequence was, that a large purchase of the refuse was made.

XXXIV.—*Of the Composition of Brewer's Draff or Grains, and its value as a food for Milk-Cows.*

A difference of opinion having arisen between the buyers and sellers of brewers' draff in Edinburgh regarding its value, and the price that ought to be paid for it, Mr Girdwood thought that some light might be thrown upon this question by a chemical analysis. He caused some of it, therefore, to be sent to the laboratory, where it was submitted to both an organic and an inorganic analysis, with the following results—

1*st*, *Organic Analysis.*—A hundred pounds of the fresh draff were found to contain—

Water,	75 85
Gum,	1 06
Other organic matter (chiefly husk)	21 28
Organic matter, containing nitrogen (protein compounds,)	0 62
Inorganic matter or ash,	1 19
	100 00

From the above analysis we see that, during the digestion of the malt in the mash-tub, the protein compounds—those which contain nitrogen, and are necessary to the production of muscle in the body, and curd in the milk—are nearly all dissolved out.

2*d*, *Inorganic Analysis.*—The ash left on burning the draff was found to consist of—

	Per cent of ash	In 100 parts of wet draff.	In 100 parts of dry draft.
Alkaline salts (chlorides, with a small quantity of sulphates) and alkali,	7.60	0.90	3.72
Phosphoric acid in combination with the alkali,	2 11	0.25	1.04
Earthy phosphates,	48.00	5 81	24 06
Silica,	41.51	4.94	20.46
	99.22	11.90	49.28

An examination of the above numbers suggests the following remarks in regard to the value of draff in comparison with other kinds of food.

a. The quantity of water present in it is 76 per cent; in this respect it approaches very near to potatoes, and some other varieties of green food. It contains, however, considerably less than the turnip or the cabbage.

b. The greater part of the solid matter, as we should suppose, consists of husk. This is not wholly insoluble in the stomach of the cow, nor without considerable nutritive power. It is impossible, from theoretical considerations, to assign any definite value

to this husk; but the experience of the cowfeeder seems to show that it is not by any means worthless in the feeding of milk cows. In the grains of the brewers it is generally understood that the proportion of nutritive matter left is much less than in those of the distiller.

c. One important result is the small proportion of protein compounds, amounting only to two and a half per cent in the dry grains. No doubt this proportion will vary in different samples. It is probably attached to the husk in the form of coagulated albumen, which, however, is dissolved and appropriated in the stomach of the animal.

The draff weighs about 46 lbs. to the bushel, and costs 3d. to 3½d. for this weight. One hundred and sixty pounds of draff contain one of albumen, and this weight costs 1s. Five pounds of oil-cake contain one of albumen or other protein compounds, and costs 5d. This ingredient of the food, therefore, is cheaper in the form of oil-cake than in that of brewers' draff.

d. Again, the quantity of ash left by the dry draff is about five per cent. One hundred pounds in the wet state contain 0.6 lbs. of phosphates, or 160 lbs., costing 1s., contain 1 lb. of phosphates. But 33 lbs. of oil-cake contain 1 lb. of phosphates at a cost of nearly 3s.; thus the phosphates are cheaper in the form of draff.

Hence a mixture of other food, such as oil-cake or beans, along with it, is recommended where the draff is to be used most economically and with least waste.

e. A part of the feeding value found in the draff by past experience, is probably to be ascribed to the steeping it has undergone, rendering the otherwise innutritive or slowly nutritious matter soluble in the stomach, and thus admitting of less waste.

Turnips are the kind of food most usually given with brewers' grains. The following letter from Mr Caird, Baldoon, near Wigton, shows the profit of feeding milk-cows upon draff and turnips, compared with beans and turnips, according to his experience.

"I have fed for the last two winters a large dairy stock in the following manner, for between 6 and 7 months, or 200 days—

Each cow half a bushel of draff (23 lbs.) per day, for 200 days, 100 bushels at 3d., ...	**L.1**	**5**	**0**
Each cow, (22 lbs. per day,) 2 tons of turnips, at 10s. .	**1**	**0**	**0**
	L.2	5	0

"And the dairyman to whom my cows are let prefers this feeding to the following, which is the usual allowance in this district to a dairy stock—

Each cow 4 tons of turnips at 10s., ...	L.2	0	0
... 2 bushels of beans, ground, at 4s. 6d., .	0	9	0
	L.2	9	0

In both cases the same fodder is given.

"On the draff and turnips the cows give fully more milk and butter, both of which are well tasted, and they keep themselves in better condition than when fed on turnips alone. With this feeding they are a very healthy stock.

"On the turnips and beans, the butter and milk are always strong tasted, and the cows are not kept in such high condition as on the draff and turnips.

"If cows get an unlimited supply of turnips, they may yield more milk than on the quantity of draff and turnips mentioned above. They do not eat beyond a certain quantity of draff, while it is difficult to satisfy their appetite for turnips.

"The question as to which of the two is the cheapest food, depends altogether on the respective money values of draff and turnips in any given locality."

XXXV.—*Composition of the Ash of the Arundo phragmites, or Common Reed.*

During one of my recent visits to the Carse of Gowrie, my attention was again drawn to the length of straw which prevails in new alluvial soils, and especially in such as are reclaimed by warping, or otherwise, from the sea or from rivers. The inconvenience of this is, that it is often too weak to bear the weight of the grain, and the corn crop is apt to be laid in rainy weather. It has been said, but hitherto without any proof from actual analysis, that this weakness of the straw is owing to a deficiency of silica, and that the application of manures containing silicates would strengthen it and support the ear.

In reference to this point, it occurred to Sir John Richardson, that probably the common reed (Arundo phragmites,) which grows so abundantly on the margin of the Tay in some parts of the Carse, might, if burned, leave an ash so rich in silica as to admit of its being applied with advantage to the young corn. At all events, if it was so, it would afford the opportunity of making a trial with a substance not difficult to be procured. The suggestion appeared to me a valuable one.

He accordingly sent a quantity of reeds to the laboratory to be burned and analysed, which was accordingly done with the following results:—

a. The dry reed left 1.62 per cwt. of ash—a very small proportion from a plant so nearly allied to the grasses—though two or three times as much as would be left by an equal weight of wood.

b. The ash, on being analysed, was found to consist of—

Potash, Soda, ...	4.80
Lime, .	6.06
Magnesia,	0.24
Oxide of iron,	0.93
Phosphoric acid,	3.19
Sulphuric acid,	5.49
Chlorine,	0.17
Silica, .	78.91
	99.79

It thus appears that the ash of this plant is very rich in silica, containing nearly four-fifths of its weight of this substance, and, besides, about 6 per cent of phosphate of lime, and 10 per cent of the sulphates of potash, soda, and lime.

It is not quite certain that the whole of the silica in the ash could readily be taken up by the roots of growing plants; but, for the purpose of a trial, I recommended that, instead of being burned to an ash, the reed should be charred, or burned in a smothered fire only. The black dust thus obtained, may be dibbled in with the corn, or applied in still weather as a top-dressing; or, where guano is used, may be advantageously mixed with this manure before it is applied to the soil.

It is doubtful, however, whether the tall straw of the Carse lands be really deficient in silica—in fact, the average proportion of silica contained in a strong glazy wheat straw is not yet known. I propose, therefore, to investigate this point during the present autumn, and shall be obliged to any members of the Association who will forward to me at the close of the present season a pound or two of any ripe wheat straw which appears remarkable in any way.

XXXVI.—*Of the Composition of the Carob Bean.*

The carob bean, the fruit of the carob-tree or *Ceratonia siliqua*, is thus spoken of by Professor Lindley in his "Vegetable Kingdom," pp. 549–550.

"Under the name of the carob-tree, or algaroba bean, it is consumed in the south of Spain by horses, and has been imported into this country, it is said with profit, as a substitute for oil-cake. The dry pulp in which the seeds are buried is very nutritious, and is supposed to have been the food of St John in the wilderness, wherefore it is called locust-tree and St John's bread. Singers are said to chew this fruit for the purpose of improving their voice.—*Pharm. Journ.*, 3-79. The seeds of the carob-tree are said to have been the original carat weights of the jewellers."

Mr Thomson of Leith, one of the members of the Association, having lately received a considerable consignment of these beans,

brought a sample of them to the laboratory to be analysed, with the view of testing their real theoretical value. They have therefore been examined with care, and their composition was found to be as follows—

	Per cent
Impure sugar,	46.76
Gum, and a little colouring matter,	4.46
Glutin, and coagulated albumen,	3 32
Fat,	0.34
Woody fibre and starch,	22 51
Water,	22.38
	99.77

This bean, as appears from the above analysis, is remarkable for the large quantity of sugar it contains—about 47 per cent of its whole weight. The protein compounds—glutin and albumen—are in comparatively small proportion. It ought to be given, therefore, along with common beans or oil-cake to growing stock. A little of it may make a good addition to the ordinary food where animals are intended to lay on fat. Cattle are said at first to eat the carob bean unwillingly, but pigs devour it greedily. It would be desirable to have some accurate experiments made upon its practical feeding value, compared with other varieties of common food. For milk-cows or fattening cattle it may be expected to answer well.

It is the pod, and not the bean or seed, properly so-called, that forms the nutritive part of this food. The seeds are small, dark brown, and almost stone-hard, and form about one-tenth part of the whole weight of the article as it comes to this country.

XXXVII.—*Composition of the Ash of Young Furze.*

In a previous part of these proceedings, (Art. V.) I inserted a copy of the analysis of the ash of young furze, made by Sprengel, with the view of affording to our members the best information we then possessed in regard to a plant to which the attention of practical farmers has lately been very much directed.

I have thought it of consequence, however, to have new analyses made of this ash, and accordingly put it into the hands of two of my assistants. Young shoots of furze were collected in the neighbourhood of Durham, and upon Arthur's Seat, respectively. They were dried, burned, and the ash analysed.

The recent shoots consist of—

	Undried.	Dried.
Water, ...	77.40	
Organic matter, . . .	21.23	93.94
Ash, ...	1.37	6.06
	100.00	100.00

The ash left by two samples collected on Arthur's Seat at different times, and analysed separately, were found to consist of—

	Furlonge.	M'Calmont.	Mean.
Potash, ...	20.13	16.49	18.31
Soda, ...	6.75	8.33	7.54
Chloride of sodium, .	12.39	12.06	12.23
Lime, ...	16.80	15.25	16.02
Magnesia, ...	5.27	8.31	6.79
Phosphates of lime and magnesia, and a little phosphate of iron.....	27.15	26.34	26.74
Sulphuric acid, . . .	6.07	7.50	6.79
Silica, ...	5.44	5.72	5.58
	100.00	100.00	100.00

Per centage of ash in dry furze, 6.06.

These analyses differ slightly from each other, but not more so than the ash of two portions of a plant collected at the same time, on the same spot, might be expected to vary. The ash of the furze collected in the neighbourhood of Durham, contained more magnesia and less lime and phosphoric acid; but the results are altogether so different from the above, that I delay the publication of them till an opportunity occurs of collecting a fresh supply, and of having the analysis repeated.

The above table, however, shows that the plant is very rich in phosphate of lime—every hundred pounds of the dry plant containing upwards of two pounds of the earth of bones. This is, no doubt, one source of the nutritive qualities of the young furze. I am about to have the proportion of protein compounds contained in the fresh shoots determined also, for the purpose of ascertaining if they are as well adapted to the production of muscle as they are to the production of bone.

XXXVIII.—*Of the States of Oxidation and Combination in which Iron exists in the Soil, and of the Functions performed by it.*

Some young chemists have lately published in the *Philosophical Magazine* a statement, to the effect that the iron which is found in nearly all our soils, exists in the surface soil always in the state of protoxide, and in the subsoil in that of peroxide.

This statement, which affects to be deduced from the analysis

of several soils, evidently performed in an imperfect manner, is so opposed at once to the simplest and best known chemical facts, to the simplest experiments and modes of testing a soil, to the results of actual and carefully conducted analyses, and to the expressed opinions of writers upon agricultural chemistry, that I thought it at first unnecessary to notice it.

Some members of the Association, however, having consulted me upon the subject, I have thought it might not be uninteresting to our members generally to give a brief exposition—first, of the state of oxidation in which iron actually does exist in the soil; second, of the state of combination in which these oxides are usually found in the soil; and third, of the functions in reference to vegetation which they perform.

1°. *State of Oxidation in which Iron exists in the Soil.*

There are three well-known facts which, altogether apart from analysis, should be considered sufficient to explain this point in a satisfactory manner.

a. When the first oxide of iron, either in a free or in a combined state, is exposed for a length of time to the action of moist air, it gradually absorbs oxygen from the atmosphere, or takes it from the water, and becomes converted into the second or peroxide. The iron in the surface soil is constantly exposed to this joint action of air and water—its tendency, therefore, is gradually to become converted into the peroxide.

b. But these two oxides, under favourable circumstances, combine with each other, and thus form compounds which interfere with this tendency. These compounds, of which common magnetic iron ore is one, attract oxygen from the air more slowly than the protoxide they contain would do if alone; and thus the change of the whole into the peroxide is in some cases indefinitely delayed. The existence or production of these compounds in the surface soil, therefore, preserves the iron to a certain extent in the state of protoxide; so that, however long the surface of a soil may have been exposed to the air, it is unlikely that the whole of the iron it contains should be found upon examination to be in the state of peroxide.

The colour of a soil is by no means an index of the proportion of red or peroxide it contains. The soils of the old red sandstone formation are usually very red. Among the rocks of this formation occur beds of marl of an intense red colour, which impart their own hue to the soils which are formed from them, or with which they are mixed.

During a late visit to the red sandstone district of Berwickshire, I observed in the neighbourhood of the limestones described above, in article XXX., occasional beds of marl of an intense

purplish red colour, and which might have easily been mistaken for beds of hematite.

On entering Berwickshire by Soutra Hill, they may also be seen cropping out on the east side of the valley, and tinging the whole adjoining soil of a bright red colour.

On the slope of the hills above Langton, near Dunse, I collected two specimens of this red marl, and caused them to be analysed. The proportion of iron they contained, and the state of oxidation, was as follows—

	No 1.	No. 2.
Protoxide of iron, . . .	3.84 per cent.	4.10 per cent.
Peroxide of iron, . . .	3.53 ——	2.09 ——
Total oxides of iron in the marl,	7.37	6.19

Thus the proportion of iron was very much less than their appearance indicated, while, notwithstanding their prolonged exposure to the air, the proportion of protoxide was greater than that of peroxide. The tendency of the two oxides to combine with each other, and perhaps with alumina also, may have lessened, or for the time have overcome, the ordinary tendency of the peroxide to absorb oxygen from the air.

c. When the peroxide of iron is mixed with decaying vegetable matter, it gives up a part of its oxygen to the organic matter, and is changed into protoxide.

When soluble vegetable matter, such as humic acid, is added to a solution containing this red oxide of iron, protoxide of iron is gradually formed. The same takes place in the soil where it is mixed with decaying vegetable matter. This oxygen of the peroxide is employed to hasten the decomposition of the organic matter, and to forward its ultimate connexion with carbonic acid and water. Thus, in our cultivated soils, two antagonist principles are at work—the one tending to produce the peroxide, the other to bring it back again to the state of protoxide. The latter absorbs oxygen from the air, and is converted into the former; the organic matter takes this oxygen from the peroxide, and brings it back again to the state of protoxide.

Such being the change that takes place, it is obvious that all our soils in which iron is present must contain a variable proportion of both oxides—a proportion ever varying in the same soil, and which can only by accident be the same in the case of any two soils which may be taken.

A knowledge of these facts ought to settle the question as to the state of oxidation in which iron exists in the soil. We ought, in most cases, to find both oxides present; but the proportion of protoxide ought to be greatest where the land is richest in vegetable matter, and has lain for the longest time undisturbed. The

peroxide should increase with the poverty in organic substances, with the frequency of ploughing, and with the length of time during which, after ploughing, it has been exposed to the air or allowed to be in naked fallow.

But I was unwilling to leave the matter on these general elementary chemical grounds, which the chemists to whom I have alluded have either not known, or have not considered. I therefore caused a series of seven alluvial soils from Jamaica, which had been sent to the laboratory, to be analysed, and which were rich in iron, to be carefully examined, with especial reference to the relative proportions of the two oxides present in them. These analyses were performed by my first assistant, Mr Fromberg, and the following were the results:—

ANALYSIS OF SOILS FROM RUNNY GUT ESTATE, MONTEGO BAY, JAMAICA.

	No. 1.	No. 2.	No. [illegible]	No. [illegible]	No. 7.	No. 8.	No. 9.
I. BY WASHING.							
Clay, fine sand, and organic matter	9[illegible].[illegible]2	96.43	88.03	90.32	74.14	93.42	95.46
Gravel, and coarse siliceous and calcareous sand	[illegible].95	3.57	11.97	[illegible].68	25.8[illegible]	6.58	4.54
	100.00	[illegible]	100.00	100.00	100.00	100.00	100.00
II. BY ANALYSIS							
Organic matter	7.51	7.73	8.13	8.80	7.78	14.01	14.55
Alkaline salts, (soluble in water and acids)	1.11	0.57	1.07	0.60	0.76	1.83	1.72
Gypsum, sulphate of lime	0.60	0.22	0.37	0.30	0.59	0.51	0.39
Alumina, (soluble in acids)	5.93	3.07	6.54	3.51	6.36	10.83	9.47
Protoxide of iron	0.82	2.61	2.92	1.56	1.42	3.08	3.10
Peroxide of iron	4.17	1.36	2.46	3.23	4.17	2.89	3.09
Carbonate of lime	41.61	27.30	31.26	37.[illegible]5	32.16	14.34	6.18
Carbonate of magnesia	1.82	1.19	2.67	1.[illegible]	2.39	0.72	3.94
Soluble silica	0.24	0.15	0.26	0.[illegible]	0.12	0.24	0.19
Insoluble siliceous matter	[illegible]5.12	55.04	41.34	4[illegible].[illegible]5	43.88	5[illegible].86	56.11
	99.73	99.84	100.01	99.87	99.93	99.07	100.11

These analyses establish what the considerations above presented entitle us to conclude without analysis: that our soils contain iron in both states of oxidation, and that the proportions of the two oxides are exceedingly variable.

2°. *States of Combination in which the Oxides of Iron exist in the Soil.*

But these oxides of iron are not merely mixed with the other

ingredients of the soil, they are very frequently in a state of chemical combination with other substances. It is well known, that in peaty and moorish soils it often occurs in combination with sulphuric acid, forming common green vitriol, which exercises an injurious effect upon vegetation.

But they are more frequently combined with organic matter—with the crenic acid already described, and with other acids not yet investigated. The well-known ochrey deposit which forms in our drains, and is deposited by the waters of many springs as they flow along the surface, consists of such a combination. Bog iron ore is another form of the same. Some ochrey soils consist almost entirely of such a compound, especially where peat abounds in the neighbourhood; and the same is true of the pan, which in many districts collects in the under soil, and forms a cake through which the roots cannot penetrate.

In our most fertile soils the same is the case. The organic matter, as it decays, forms acid substances, which unite with the oxide of iron, and produce the combinations in question. In some cases these compounds are intimately mixed with the soil, in minute invisible particles; in others, as in many of the Jamaica soils, the particles collect, or are aggregated together into little globules, locally called shot, which consist almost entirely of a mixture of the two oxides of iron, in combination with organic matter. The proportion of organic matter in these combinations is usually very large, amounting to 20 or 30 per cent of the whole weight. By boiling in a solution of caustic or carbonated alkali, (potash or soda,) the acid is, in considerable proportion, separated from the oxides of iron.

When the soils containing them are treated with muriatic acid, they are dissolved; but upon the addition of ammonia to the filtered solution, the oxides fall, and usually carry with them again a large proportion of the organic matter with which they were originally combined.

3°. *Functions of the Oxides of Iron in the Soil.*

The functions which these oxides perform in the soil are very interesting, and are at the same time very useful to vegetation.

We have seen that there is in the soil a kind of struggle between the iron and the organic matter for the possession of the oxygen, which the former takes up when it changes from the state of *pro-* to that of *per-* oxide. The vegetable matter robs the peroxide of one-third of its oxygen, and this protoxide revenges itself again, so to speak, at the first opportunity, by taking a fresh dose of oxygen, either from the air or from the water with which it is in contact, or from both.

In the joint presence of air, water, and protoxide of iron, a

portion of the water is always decomposed, and its oxygen appropriated by the iron. The hydrogen of the water, as it is set free, unites with the nitrogen of the air, and forms ammonia, which is retained by the soil, and serves to promote the growth of plants.

Thus the antagonist reactions of the organic matter, and of the iron, are constantly producing good effects in the soil. As often as the former takes oxygen from the latter—this again decomposes more or less water, and produces more or less ammonia, while it is itself reconverted into peroxide—so that the joint presence of iron and of vegetable matter in the soil, if it is properly broken up and exposed to the air, contribute materially to its permanent fertility.

This is, indeed, one of the causes of the fertility of our red-sandstone soils, and the action of it, as a useful cause, demands or implies the constantly alternating production of the first and second oxides of iron.

We see, therefore, not only that the two oxides must exist in the soil—and, by analysis, that they do exist in the soil—but also, that a beautiful final cause or end is connected with their existence in these two states.

XXXIX. *Composition of an Ochrey Soil from Shewalton.*

I have stated, in the preceding article, that the oxides of iron occur in the soil very frequently in combination with organic matter. Of this I have met with an interesting example in an ochrey soil, sent for analysis by the Lord Justice-General, from his estate of Shewalton. It occurs in the hollows upon his lordship's farm of Auchingate, in which it has, at a former period, been gradually deposited from the water which rested in them. It is of a reddish brown colour, and consists of about 30 per cent of rolled sea sand, mixed with what has all the appearance of an iron ochre, without any visible quantity of vegetable matter.

When subjected to analysis, however, it was found to consist of—

Organic matter.	21.66
Alkaline salts, soluble in water and acids,	0.73
Gypsum,	0 07
Oxides of iron,	42 91
Alumina, soluble in acids,	4 80
Carbonate of lime,	0.28
Carbonate of magnesia,	0 33
Soluble silica,	0.06
Insoluble silicious matter or sand,	29.20
	100.04

Besides the sand, therefore, the chief constituents were oxide

of iron, with a little alumina in combination with organic matter, the presence of which, from the colour, was not to be anticipated.

It is, therefore, a deposit from springs containing in solution the protoxide of iron, in combination with an organic, probably the crenic acid. Such waters come to day perfectly colourless; but as the protoxide which they contain absorbs oxygen from the air, the combination becomes insoluble, and falls in the form of the fine ochrey powder or mud so frequently observed in the course of such springs. It is not impossible, however, that infusorial animals of the genus *Gallionella* may have assisted in forming the soil in question, if, during its production, the water remained stagnant in the hollows for any length of time.

XL.—*Composition of Bog Iron Ore from the island of Islay.*

On the surface of dry moorish and boggy heaths, those accumulations of ochrey matter, which, in other localities, collect in the under soil, are often seen to form, on the very surface, large masses of more or less hard, sometimes even rocky, matter, which has long been known, and in former times was extensively smelted, under the name of bog iron ore.

For the purpose of examination, I lately collected a portion of this matter while walking over a moor in the island of Islay. It was of a loose friable texture, yellow, ochrey, and easily soluble in acids, with scarcely any residue. Upon analysis it was found to consist of—

Water	4 88
Organic matter, soluble in potash and soda, and precipitated by acids, (humic acid ?) .	2.80
Organic matter, soluble in ditto, ditto, and not precipitated by acids, (crenic acid ?) .	16 84
Oxide of iron, ...	56.56
Alumina, soluble in acids, ...	17.86
Insoluble siliceous matter, ...	1.24
	100 18

Like the ochrey soil above described, therefore, it consisted of oxide of iron and alumina in combination with organic acids. Of these acids, it was discovered that at least two were present in this ore—one like the humic and ulmic precipitated by acids from its solution in alkalies, the other like the crenic, apocrenic, and mudisous acids, not thrown down by acids. Probably more than two such acids were contained in it—a subject I propose hereafter more minutely to investigate.

XLI.—*Composition of several varieties of Ochrey Pan from Ardgour in Argyleshire.*

I have already, in article XXXVIII., stated that the moorland pan, which occurs so frequently and extensively in the under soil over large tracts of country, especially in Scotland, consists of oxide of iron in combination with organic matter in large quantity. In illustration of this, I present the following analyses of several varieties of such pan sent to the laboratory by Colonel M'Lean of Ardgour. Upon a part of his estate deep moss rests upon gravel and land. After clearing away the moss, the water still refuses to descend below the gravel. Upon examination, this is found to be caused by the existence of an ochrey pan at various depths below the surface, through which the water cannot penetrate. Sometimes this pan appears in the form of a moss of thick hard conglomerate, in others it is less than an eighth of an inch thick, and readily yields to the fingers. In both cases it is equally impervious to water. The thicker masses consist of gravel and the thinner of fine sand, in both cases bound together by ochrey cement.

Upon analysis these several varieties of pan were found to consist of—

	Thick sandy pieces.	Thin cups.	Granitic conglomerate.
Water,	1.4	1.6	1.5
Organic matter,	2.7	24.5	3.2
Oxide of iron,	8.6	37.5	9.7
Soluble alumina,	1.7	0.0	2.0
Sand and earthy matter,	85.9	34.8	83.9
	100.3	98.4	100.3

If we deduct from the numbers above given the stones and sand, we see that, like the bog iron ore, the cementing material of this pan consists chiefly of oxide of iron in combination with organic matter. The composition of this ochre, calculated from the above table, by deducting the stones and sand, is as follows—

	Thick sandy pieces.	Thin cups.	Granitic conglomerate.
Water,	9.72	2.51	9.15
Organic matter,	18.76	38.52	19.51
Oxide of iron,	59.72	58.97	59.14
Soluble alumina,	11.80	00.00	12.20
	100.00	100.00	100.00

The cement, like the bog ore and the deposit from springs, is derived from the water which has descended from the superjacent

peat, impregnated at once with iron, and with organic acids derived from the decaying vegetable matter which has formed the peat.

XLII.—*Of the proportion of Nitrogen and Protein Compounds in Amalfi Wheat, and in Indian and Guinea Corns.*

1*st*, *Amalfi Wheat.*—Colonel Hamilton of Royelle, one of our members, having lately brought from Italy some of the celebrated Macaroni wheat of Amalfi, near Naples, favoured me with a sample of it which had been grown one year at Royelle.

It has been frequently stated and long believed, that the excellence of any variety of flour for macaroni, vermicelli, and the finer kinds of pastry, depends upon its richness in gluten. It was desirable to ascertain, therefore, the proportion of gluten or other protein compounds which this kind of wheat contained, with the view of so far ascertaining the correctness of the above opinion.

A portion of the flour of the whole wheat, and of the fine flour sifted out of it, was burned therefore, and the proportion of nitrogen, and consequently of protein compounds, determined in the ordinary manner. The following were the results:—

	Water per cent.	In Ordinary State.		In the Dry State.	
		Nitrogen per cent.	Protein Compounds	Nitrogen per cent.	Protein Compounds.
Whole wheat,	12.18	2.75	17 32	3.14	19.73
Fine flour of ditto,	13.30	1.85	11.62	2.22	13.93

These results show—

a. That the flour of the whole grain is very rich in gluten—considerably more so than the fine flour sifted out from it. This is to be accounted for on the supposition that the part of the grain which is most abundant in starch crushes better and more easily under the mill-stones than that which, being richest in gluten, is probably also tougher and less brittle. The result is also consistent with the greater nourishment generally supposed to reside in household bread made from the flour of the whole grain.

b. The fine flour from this variety of wheat is not exceedingly rich in nitrogen—not so much above our English average as to justify any strong opinion as to its excellence for the macaroni maker being dependant upon the greater proportion of this constituent.

I believe, indeed, that the opinion in question ought to be regarded more in the light of a conjecture than of a fact ascertained by experiment. It is very desirable that all such conjectures should be carefully tested—that in this case for example, varieties of flour pronounced by the baker upon trial to be of a given quality should be put into the hands of the chemist that he may determine accurately their chemical constitution.

2d, Guinea and Indian Corn.—Guinea corn is a small round seed, a little larger than mustard or millet seed, which is used in the West Indies for feeding poultry. Dr Phillips of Barbadoes, one of our members, being of opinion that it might he employed as human food, requested me to determine its richness in protein compounds—the muscle forming part of vegetable food—in comparison with Indian corn. I therefore caused a sample of each to be burned for nitrogen, when the following results were obtained:—

	Water per cent	In Ordinary State		In the Dry State	
		Nitrogen per cent	Protein Compounds	Nitrogen per cent	Protein Compounds
Indian Corn .	12 81	1 83	11 51	2 10	13 20
Guinea Corn ..	13 76	1 18	7 42	1 36	8 60

According to these results, the Guinea corn is less rich in nitrogen or protein compounds than Indian corn—though not much less so than some varieties of English wheat. In Indian corn, the proportion of these ingredients is about equal to the average of English wheat.

Indian corn meal analysed by Mr Hersford, from two localities, gave, in the ordinary state of dryness, 11.53 and 12.48 per cent of protein compounds; results which come very near to that obtained as above, in the laboratory of the Association.

ON THE DISEASES OF THE LARCH.

By Mr Robert P. Newton, Hallyburton, Forfarshire.

[Premium, Ten Sovereigns.]

For the last few years the diseases incident to the larch have become the subject of interesting inquiry to planters. These diseases are chiefly, if not entirely, three in number, and are popularly styled *heart-rot*, *canker*, and *white bug*. The first of these has been long known, and is indicated by a rot in the heart of the trunk of the tree; the second has only been extensively known or felt within these ten years, and is discovered by numerous cankers appearing on the trunk and branches of the tree; and the third shows itself by a downy appearance over the surface of the trunk and branches of the tree. Let us consider these diseases in order.

I.—The Heart-rot.

This is a disease which seems to be found in a great variety of circumstances. It does not appear to be peculiar either to any particular soil or situation; but, as its name almost implies, the rot does not appear until the tree is at least from 15 to 20 years of age when the red wood begins to form. It is not perceptible until the tree is cut down, and then it exhibits a complete cavity of decayed substance penetrating from the root, more or less, through the body of the tree. Very old larches do not seem to have been affected with it.

We think this disease may arise from many circumstances. It may be produced, first, by the soil. In high, wet, and exposed land it frequently occurs, and in the shaley soils or poor clay and sand. It is also often found in retentive soils where the land is undrained. Second, it may arise from injudicious planting. For if, as often happens in this operation, the tap roots are carelessly shortened for the planter's convenience, it is not to be wondered at if the pith shall attract too much of the moisture of a soil probably prone to wetness at any rate, and so commence the evil; and, third, it may arise from injudicious thinning—by thinning too much or too little. If too much, then the wind is apt to break or loosen the roots, and lay the foundation of the mischief—if too little, by inducing an unhealthy action over all the plantation.

Feeling convinced that, in prescribing the subject of this paper, the object of the Highland and Agricultural Society was more to obtain practical information upon it on a large scale, than to look for so limited an exposition of it merely as could possibly come within the scope of any single individual's observation or experience, we sent printed queries to foresters and others likely to be conversant with the subject, in different counties, as appearing likely to prove the most effectual method of eliciting the best information and the best opinions. We propose, after specifying those queries, to embody extracts from some of the answers, so far as they are applicable to the different branches of our subject, and those which we shall first submit will apply to the disease we have just been considering, viz. the dry-rot.

The queries were as follows:—

1. What is the extent of the larch plantations in your charge?
2. What are their different ages?
3. Does any disease prevail among them? If so, at what age or ages have you known them to be attacked?
4. What is the nature of the disease or diseases, and how does the tree seem affected?
5. Where disease prevails, does it, generally speaking, affect tracts of plantations, or is it sometimes partial, attacking trees in different positions over the ground?
6. Have you observed that the disease or diseases are peculiar to any particular soil or subsoil, situation and aspect, and what are these?
7. What is your opinion of the cause of the disease or diseases respectively?
8. Do you recollect when you first observed disease, and about what time might this be?
9. Did you ever apply any remedy for the disease, and with what success?
10. Have any of the larches which have once caught disease revived, and under what circumstances has this happened?

The first extract from some of the answers sent us to the above queries, in regard to the dry-rot, is from a most intelligent overseer on a very large estate in Lanarkshire. He writes, that "frequent instances of the dry-rot occur in the higher wet and exposed districts, chiefly, I believe, in the shaley soils, a mixture of poor clay, sand, and decomposing shale; and this generally in plants about fifteen years old. I do not consider this disease of a hereditary nature, nor do I think it induced by the nature of the soil in which they grow, but rather from accidental circumstances. In planting the larch now-a-days, as well as in former times, it frequently happens, both for the convenience of the planter and also from custom, that the tap roots are shortened in order to make the plants a little more manageable; when they are so planted, and if the soil be damp or retentive, the pith, by its capillary powers, will take up an undue proportion of the sur-

rounding moisture, and hence the evil commences. Again, when plantations are much exposed to high winds, and when by injudicious thinning they are more and unequally exposed, a breakage of roots must ensue, and if the soil be damp, rot, in my opinion, must also ensue. Every one acquainted with the larch knows how difficult it is to heal wounds in this as in any of the fir tribe, and that this seldom occurs until the resin ceases to flow; and it becomes a question whether, by its exuding under ground, the circumstances prevent the wound being covered thereby; and also whether the pith contains any resinous matter at all. These are, of course, mere suppositions, but at all events there can be no harm, but rather the contrary, in preserving as much as possible all the roots, and especially the tap roots."

Let us mark, then, from the above, that the greatest care in planting at first will at least prevent reflections on this account when we meet with the heart-rot.

The next extract from our communications on the disease under consideration is from Roxburghshire. The writer is evidently both very observant and experienced on the subject. He remarks, that a disease in the larch which threatens to be of a "serious kind, is the rot, commencing at the root and extending upwards along the pith or heart of the tree, and makes its appearance about the age of fifteen or twenty years, or about this time, or soon after the formation of the red wood. It does not appear until the tree is cut. The tree is most liable to it when planted on a clay soil. It seems rather to be a new disease, as the very old trees seem not to have been affected by it. Should this be found generally the case, then I apprehend the cause of the disease must be sought from the seed, which probably of later years may have been obtained from different places than that from which the more early was procured, and thus a larch of a different variety gradually and imperceptibly introduced, which even the botanist may not be able to detect, not being distinguished from any other variety in its external appearance. The analogy is borne out by reference to the various cultivated grains, the farmer insensibly losing the original seed, which, at its first introduction, was so highly valued.

"Some allege that this disease occurs most frequently on land that had previous to planting been under tillage, and of course they attribute the disease to that cause. I, however, have not found it to prevail on such places more than in waste places that had never been under the plough. This comparison, no doubt, is defective from a smaller quantity of the first than the last being planted. The disease seems to occur more in land of a wet and spungy nature, or on that having a tenacious clay subsoil.

Should this be the cause, which is the most probable of any supposition arising from the soil, then complete open draining should be the remedy. Should this even fail, the expense of draining would not be lost, if my former statement be correct, as it would be fully repaid in the produce and beauty of a thriving and healthy plantation."

The opinion here given, that degeneracy in the plant itself has to do with the disease, must be taken cautiously, although not rejected; for, let us attend to some of the remarks contained in another communication to us on the subject of the heart-rot, from a forester on a large property in East Lothian. He says—"The principal disease the larches are affected with here, is premature decay, and rottenness in the heart—commencing, generally, at about twenty-five years old. The decay takes place at the root, going upwards to the extent of six feet, never further. It seldom goes beyond four feet, often at three, and a number not more than a foot and a half. Some of the older trees are as hollow as pumps; others are quite soft and rotten. The outward appearance of the trees is noways altered. It is impossible to tell a sound from an unsound one, the trees continuing to grow vigorously. The disease prevails regularly all over the plantations, with the exception of a few old trees. This disease is common to larch all over the country, but never have I, in all my experience, seen it to such an extent as here. Where the larch grows, the soil, with one exception, is all sand, which in some places is also the general subsoil, the situation being low and sheltered. I consider the soil as being the sole cause of the decay—sand having a tendency to make trees grow with great rapidity. It has done so here. Finer-looking trees of their age cannot possibly be—carrying their thickness from bottom to top, and a great height. There are about three acres of larch growing upon a soil of soft loamy sand. These are less affected than any others. There is an acre growing upon a soil of mere sand, that has been blown from the sea-shore at some period, and these are truly worthless—not one in three being sound, but a good size of tree for their age, and still growing well. There are other patches on the ground all in the same state, as the soil is less or more inclined to sand. But the oldest trees we have—a little upwards of an hundred years—grow upon a kind of ridge a little exposed, with a stiffish soil and subsoil of clay; some call it marl. These trees are excellent. I have cut several of them fifteen inches in the side of the square, all perfectly sound, and a quality of timber I have never seen surpassed. I find, from inquiries I have made, there were never any unsound ones among them. The last I cut of them, a gentleman offered two

shillings and sixpence per foot for. As the decay proceeds from the soil, the only remedy I can think of, is pretty severe thinning. Accordingly twelve years ago, I commenced thinning the largest division I have, about thirty-five years old, with this view. Going on in this way, I found the number of decayed trees diminishing, till last spring (1843) I cut several loads of them, and found very few unsound trees amongst them. The trees stand wider on the ground than they would otherwise have been, but they are a greater length, and, having plenty of room, they will swell greatly to the girth, and become ultimately a heavy crop of timber."

From the remarks of this writer from East Lothian, the idea seems to be confirmed, that in very old larches, the heart-rot is not generally found; and we have also the same theory maintained, that the nature of the soil and subsoil has much to do with it. And a communication from Renfrewshire is further in support of this. The writer has charge of large plantations in that county. He mentions, that where, in a cold tilly bottom, larches were taken out, he "observed a good many of them hollow and rotten in the centre." He considers this "as being in consequence of the quality of the soil they had been planted in—it being not at all adapted for larch."

A communication from Ayrshire is very similar to the information and opinions already quoted.

Answers to our queries from Argyleshire, as to this disease, say, that "heart-rot is peculiar to the soil, subsoil, and situation; viz. where the soil is thin and near the rock, where the subsoil is saturated with moisture, and also where affected with salt-water spray."

From Peebleshire, part of the answers are curious, as being in direct contradiction to some of the foregoing opinions. For instance, a forester on a large estate in that county, writes us, that he observes the heart-rot "to prevail most in the south and south-west aspects," and very little of it to be found in other directions. He says, his "opinion of the cause of the disease is over thinning; for when the trees are left thick, no disease appears among them. I find also, where the land has been under the plough, the disease is sure to be there."

We cannot conclude the extracts from the answers to our queries, which respect the heart-rot, without offering one more from Stirlingshire, sent by a forester on a large estate in that county, whose observations and intelligence are evidently of a very superior kind. This writer entitles the disease under consideration "a kind of dry-rot, or loss of vegetation in the yearly circles or growths, commencing generally at the heart of the tree, and although apparently little impaired for many years, yet the tree eventually becomes dry and scaly in the bark, as far up the stem

as the disease has advanced, and above that, the bark is fresh and smooth. I have observed the dry-rot disease peculiar to very light soils in narrow and exposed strips, gravelly subsoil, or freestone rock." In stating his opinion of the cause of the dry-rot, this writer remarks, that "it is to be regretted that among the various soils, the different aspects, the low and elevated situations, and the extent of land now under larch, the majority of them are far advanced ere the symptoms of this disease are visible. Although seemingly in a thriving state, and no external signs of disorder, yet, on being felled at the age of thirty or forty years, and sometimes earlier, they are found hollow, or traces are visible that a few years will render them useless for general purposes. We have certainly very fine specimens of larch in the county, but the above I remark generally. Larch being of the resinous kind, they are more or less affected by climate and soil; and I think, in general cases, where the roots reach the subsoil, the tree begins to decay; because, for twenty years or so, they are found vigorous and healthy, and as age comes on, and the roots set towards the subsoil, indications may be seen that their fate is a premature end. In good deep soils, at ordinary elevations, or a clayey subsoil, is where I have found them healthiest at an advanced age. Seed taken from unhealthy trees and covers may be an overlook, and also injudicious planting by inexperienced hands, from carelessness or ignorance driving the roots with their spades into improperly made slits, and also want of bolstering to prevent wind waving. These, and other minor neglects, may also contribute to impair the vegetative functions of the plant in many cases of disease."

We shall not proceed further with these extracts, but we consider them very important on the subject, as emanating from practical men unknown to, and distant from each other. We have preferred giving their own words to any mere digest of their remarks, because it is the truth we are anxious to arrive at; and there can be no more likely method of attaining this object, than by culling and quoting evidence, so to speak, of this description.

From the remarks we have quoted, and from our own experience of the dry-rot in the larch, we submit.

1. That one decided cause of the disease is a damp or tilly subsoil,—the remedy for which is draining, and, if possible, to avoid such soils.

2. That the disease may also be induced by neglect of thinning,—the remedy for which is a judicious and systematic attention to this important particular.

3. That this dry-rot may often be ascribed to careless planting, —the remedy for which is the greatest attention, first of all, to procure plants grown from healthy seed, and then to take care

that they are put into the ground in a proper manner, the roots being kept entire, the slit being made sufficiently large to contain them; at the same time, that the plants are left with a proper hold of the ground.

II.—Canker.

We come now to speak of that disease in the larch, which is best known by the name of the "Canker." Many theories have been proposed to account for this disease. Some have attributed it to the seed; others to the soil; another class to the ravages of insects, and so on. But we submit, that none of these afford proper ground for accounting for the canker in the larch, which, of late years, has extended itself so much. We meet with it in Tyrolese seed, just as we do in our home-grown seed; and the disease cannot be attributed either to the soil or to the ravages of insects upon any grounds that can apply at all generally. Indeed, the disease is met with upon soils so variable, that any one who will take the trouble to inquire for himself, will find that the quality of the soil has really nothing to do with the matter. Then, as to its being caused by insects, it is a sufficient answer to such a theory, that if insects have any thing to do with the disease at all, they are in every case visible after the wound is seen, and are undoubtedly the mere effect of putrefaction arising from its exudations, and cannot have any thing to do with the cause of the disease which produced the wound.

We state at once, that our own opinion has all along been, that although the disease called *canker* has been known in the larch for a long period, yet it has only shown itself, to any alarming extent, within the last ten years. The severe winters of 1836-7, and 1837-8 will not soon be forgotten, nor their effects upon the larch. The spring of both these seasons was unusually early, and so necessarily was vegetation. The young larch sent out its buds and leaves accordingly, but a sudden and severe check was doomed for them in both the years we have mentioned, which arrested entirely the progress of the season's growth. Not only did very severe frost ensue, but the winds were unusually high and sharp, assisting, by their influence, not a little in the injury which arose. Vegetation thus suddenly checked, what happened? When the thaw took place, the sap vessels of the tree were actually burst, and when the progress of vegetation was restored, the sap could not flow on in a natural course from where it had been arrested; but it acted as a sudden chilling of blood would do in the human body. The tree was thus paralysed, and in every case of this disease there was found a black ulcerous wound, *below* which the leaves and branches appeared comparatively healthy; but *above*

which there was generally no growth at all. Hence we conceive and maintain, that the disease in question arises from checked vegetation, caused chiefly by the severity of the winters of 1836-7, and 1837-8. Every observation and every inquiry for the last three years, tend to strengthen this opinion; and we have had considerable opportunity for both. Indeed, we think it will require us only to state briefly, what has actually taken place in regard to this disease, in order to establish our position.

The first appearance of the canker on a great scale, was in the spring of 1837, and in the following year it decidedly increased in its ravages. In 1839, 1840, and 1841, its victims did not get worse, for the most part, yet they did not improve, and the disappointed planter of such trees was in almost every case prepared to see his labours, to this extent, end in a fruitless result and serious loss. In 1842, however, it was whispered that partial symptoms of revival were observable amongst many of the diseased larches. In 1843, this appearance did not fail. In 1844, improvement was evident; and this season, 1845, we make bold to say, that there is great hope for many larches, for which, at one time, there seemed no chance of recovery. The larches in tracts of plantation attacked with this disease, resolve themselves, we think, into three stages,—the dead, the dying, and the convalescent. For the dead, there is of course no hope, and they should at once be cleared away; for the apparently dying, there may perhaps be little hope, but we cannot recommend that they should be cut down as a matter of course in every case, because they serve at least to cover the ground for a time, and to shelter the convalescent,—for we are speaking at present of tracts of plantation.

There cannot be a doubt, therefore, that it is to the severity of the seasons of 1837-8, and of 1838-9, that the disease in question to its recent extent is mainly to be attributed; but in support of this assertion, we submit the following extracts from the correspondence which we have already noticed, and from which we have already given extracts in support of the last branch of our subject:—

And, first, let us see what our Roxburgh correspondent says, in the end of 1843, upon this subject:—"In the spring of the year 1841," says he, "a disease affected the larch in some places which almost wholly destroyed the small branches of the top and side shoots of the two preceding years, and from which they have not yet again recovered, and never can be restored to their former fine appearance, though the trees are still alive, but deformed. The trees in shady places, or in wet land, and along the sides of rivers, were most affected. In these places, the summer aspect was completely converted into that of

winter—the branches being entirely divested of their leaves. Higher situations were not much affected. Although the cause of disease may always remain a fruitful field for dispute and conjecture, yet, in this case, I have little doubt that it must be ascribed to some severe attack of frost, happening at that particular period in the growth of the plant when its juices are most susceptible of impression from such a cause. This conjecture is confirmed from what is observed with some other trees in which there remains no doubt. This year (1843) the early beeches (for in these, early and late varieties occur), in similar situations with the larch, as above stated, a severe attack of frost one night, this spring, at the time when the young buds were putting out their first leaves, were so completely injured by it, as to give them a black appearance, and from which they have not yet again recovered, nor likely will this season. I have sometimes seen the top branch of the Scots fir so affected by one night's frost, as to make it fall down along the trunk, and never again regain its erect perpendicular position, though not completely destroyed, for it afterwards curved upwards to its former place—thus forming a bend in the tree."

We now quote from Stirlingshire, and the communication from that quarter, sent in 1843, ranks the disease in question as one of two great classes to which the writer thinks trees are liable, viz. internal and external; and he tells us, that the canker affects the larch "externally. This disease," he goes on to say, "I remark at two distinct stages, namely, in its original, and in its more advanced state. Its original symptoms present themselves in the tender part of the tree, or at every consecutive shoot, by a thrusting forth of the resinous juice, to a certain extent, down the tree, apparently as if the whole part was affected; but, on examination, and clearing away the bark, the black malady is found, on reaching the wood, by its putrid appearance at a particular spot or strip, where a disruption of the bark takes place. Its more advanced stages are traced by black wounds arising in magnitude, from the corrosive nature of the disease, in proportion as the tree increases in size, till the resinous qualities of that part are exhausted, or the surrounding vegetation healing the vessels or pores, and cicatrization covering the wound, but for a long time retaining the marks of the fatal infliction; and when the disease enters the branches, the tree altogether seems in a debilitated state, and then often proves fatal. Generally, it affects tracts of plantations, but, in some cases, many trees have escaped it, when their neighbours were severely attacked." At another part of his communication, this same writer remarks, that "the black, or external disease (meaning the canker) is invariably an attendant in damp, or near to damp

situations and hollows, and often even in a dry soil, especially having a northern aspect. In giving my opinion as to the disease in larches, I beg to submit the following remarks according to my present judgment or experience." And then he goes on to say, in reference to the disease in question, that although the dry-rot "may be said to be eventually fatal, this, in many cases, is instantaneous, and gives no chance (when it sets in, especially in damp, or bordering on damp situations) of any benefit from a plantation, as it attacks trees even before they are fit for stobs; for I have observed young trees at the age of three years planted, attacked by it. It is clear that this disease does not originate with the plants. Neither has the soil any tendency to produce it; because the diseased trees, (if not too far advanced,) on being cut down, show no symptoms of any disease beginning internally, and I have found them the very healthiest at the heart; consequently, it must be owing to some outward action. What this may be, may have given place to various opinions; but, in my humble opinion, at present, I would suggest the following:—The severe winter and spring frosts of several years past, have not only been injurious to the more tender kinds of plants, but many of the young oaks were nipped in their tender leaders; and in their summer state, appeared with a multiplicity of shoots, from the sap being checked in the parent stem—showing, that when the hardy oak was overcome, what must be the state of the tender (comparatively speaking) larch? The consequence is, that from the early ascent of sap in the larch in spring, and so copiously in genial weather, then a sudden transition to frost, which the pores or vessels were unprepared to resist, a kind of putrefaction takes place, and the vessels, in consequence, become disorganised where the sap has been checked, and then the resinous stuff bursts out. I find that the north and north-east sides of the tree are most conspicuously afflicted with wounds—leading me to believe, that as the severest frosty winds are from these quarters, the sap becomes more congealed and retarded in its course than what it does on the opposite side; (but, in some cases, wounds are found on both sides); these, combined with mildew and hard frost, are, I think, the causes of so deplorable a disease, so fatal in hollows and damp situations. I find, also, that some plantations, about twenty-two years of age, have had a touch of it about seventeen or eighteen years ago, and afterwards escaped it for many years; but, since 1837, till 1841 and 1842, every year has left its own doleful mark upon the different growths. The young trees planted about three or four years ago have slightly got marks of this disease upon them, and this upon the very driest soil, but northern exposure; whereas, those bearing a southern exposure are scarcely touched; but in situations bordering on damp, they are all

almost dead. I observe the trees in favourable situations, (rather elevated ground,) if not too much debilitated, so far recovering and renewing their foliage; and I would remark, if we shall have favourable springs, and the autumn growths get thoroughly ripe, caution and patience to be exercised in cutting no more of the trees than what is necessary, according to the regular course of thinning, with a view, in a few years, to their recovery: many of the wounds are already cicatrizing; and although we cannot have the timber, on being cut up, without black spots, yet we may have good standard trees, and if allowed a long existence, the marks will bear but a small proportion to the accumulated quantity of fresh timber."

A communication from Argyleshire in 1843, informs us that no disease whatever had manifested itself throughout very extensive larch plantations on an estate in that county.

From Fifeshire we are favoured with the following remarks by a forester on large estates there, dated in August 1843:—"Our four years' old larch," he says, "are thriving well, but all the rest are gone back, except the old, with a few exceptions. The nature of the disease seems as follows:—the tops and branches are dead, and the life of the tree comes to the outside with young growths from the trunk. Disease seems to prevail most in all the low-lying marshy ground. Diseases are general in every soil and subsoil lying in a north exposure. My opinion is, the strong frost the last of May and first of June, which nips the tender growths at the top, and causes the life of the tree to go downwards. It is four years since I observed the first attack upon the larch. The strong frost and wind in the month of June caused a great failure to take place in this district. Our old larch is all healthy, lying in a south exposure where the severe frost is not so strong."

The next extract we shall give is from Forfarshire. The remarks quoted are from a forester on a large property. "Disease does prevail, and that to a very great extent, and no age is exempt from it; indeed, I may say that they are dying almost a universal death. The first appearance of disease is generally a large blotch or blister in the side of the tree, and soon afterwards the tree gets a sickly appearance, and then a small white fungus-looking thing grows all over it. It then begins at the top, and dies downwards. I have not been able to discover any partiality, as it generally makes straightforward work. I have it under my charge in all kinds of soils and subsoils, but I know no difference of any of them. On a hill with a north aspect I find that disease prevails most at the top or ridge; that is to say, if the wood terminates there. But in fact there is no aspect exempt from its terrible ravages. It is not very easy to give an opinion on this disease, but as the larch is not a native of this country, but of a

far colder one, (that is, in the winter season,) but, as far as I can learn, when spring sets in there it is far more steady than our spring weather generally is, and does not shift from heat to cold, and *vice versa*, as it has done with us for these great number of years past. We have had fine warm weather in the months of March and April, which brought the sap of the larch into full operation; then, in the month of May, we generally have had stormy weather accompanied with frost, which in my opinion drives the sap that was rising in the tree as it were backward, or at least stopped it from rising, which forced it to make a passage at some place; and this I consider makes the blotch or blister on the side of the tree. This has been my opinion for these some years past; but whether I am right or wrong I cannot tell; so I should be very happy to have some convincing proof for or against it, as I think the cause of the disease is in the atmosphere, and not in the soil or subsoil."

A writer from Wigtonshire does not seem to be acquainted with this disease in that county in September 1843.

We are also informed by most respectable authority from Ayrshire, of date October 1843, that this disease is scarcely known there.

The disease is known in Selkirkshire, according to the information of a correspondent.

We shall carry these extracts no further. We trust the unanimity of the opinions they evince will at least gain for us, without hesitation, the admission that the disease called *canker*, in the larch, to the extent it has gone of late years, arose entirely from checked vegetation in the manner already stated. This, we think, we have established; but there are two things of much importance in connexion with it to which we beg to call attention.

1. The first is, that the disease has prevailed most in eastern and north-eastern exposures. In our own experience this is the case, but if we regard the extracts given, we shall find that, independently of remarks occurring in support of this assertion in *localities*, the disease is found to prevail extensively in Roxburghshire, Fifeshire, and Forfarshire, all eastern counties, whereas in Argyleshire, Ayrshire, and Wigtonshire, it does not seem to have attracted the attention of our correspondents at all. In Aberdeenshire (a north-eastern county) it also prevails extensively. We mention these counties in particular, merely for illustration.

2. The second remark to which we would call attention, is, that where the disease has occurred extensively, it has been most fatal in hollows and marshy places, especially if exposed to the north-east wind.

It may perhaps be asked by some, why the larch should be the only tree of the pine tribe so severely attacked, and our theory is still borne out by the answer. The young Scots fir we have

observed partially affected by the severity of the seasons we have described, but being thicker in the bark than the larch, it recovered. The spruce again, thicker still in the covering, seems to have entirely escaped.*

III. White Bug.

We are desired to notice, in connexion with the diseases of the larch, one called *white bug.* But we have little to say in reference to it. It does not seem to us so peculiar to the larch as some other trees. Where it does occur, it is generally in damp ground. It appears mostly in the summer season, and is indicated by a white downy appearance, or substance, almost covering the tree. It is by many supposed to consist of the nidi of a small fly, each nidus containing five or six eggs, and each of these producing a larva. Where the effects of this disease appear, it is not unlikely they are produced by these insects absorbing the sap and retarding the growth of the tree. But the tree does not suffer seriously from this disease for the most part. The downy appearance goes off after a little time, and the tree returns to its former vigour. It is difficult to assign any probable cause for this disease, if it is one, as all soils and situations are subject to it, although damp soils seem to be most liable.

Since the larch, always a most valuable tree, appears in these days likely to prove more so than ever, it becomes of great consequence to cultivate a minute acquaintance with its habits and management. Once arrived at full growth, there is nothing to fear for its complete health and vigour; but, in its earlier years, the larch has shown itself, in late experience, if not a delicate, at least not a very hardy tree. In planting it, therefore, great caution should be observed. We do not think it is particularly nice in regard to soil, if it is dry, and not over rich nor retentive in the subsoil. But, from what we have seen, great caution and care should be observed in placing the young nursery plant in the ground, with every fibre and root which it has brought along with it, uncurtailed. Eastern and north-eastern exposure had better also be avoided.

The larch is sometimes planted as a nurse to hard wood, sometimes as a mere variety, sometimes as the only tree on the ground. We do not recommend that larches alone should, after what we have seen, be ever risked as the entire timber over a large

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* And both these trees are moreover protected from frost by their leaves being persistent.—Editor.

extent of ground. It will be better to mix them with Scots fir. This gives two chances of success for one. Both descriptions of timber are becoming every day more valuable, and both afford a most beautiful variety of colour and shade in the landscape of summer, while to that of winter the Scots fir gives a verdant hue.

Again, let the greatest attention to the process of clearing and thinning be given. If the young plants are placed among long grass, or overtaken by whins or broom, or attacked by vermin of any kind, let the most earnest heed be given to provide the self-evident remedy for these evils. In the subsequent stages of the plantation's growth, great care should be taken also never to allow the trees to get crowded; a pretty safe rule being, to have the trees always at such a distance, as that, while the branches *almost* touch each other, they are not *actually* in contact. It will often be very necessary in a plantation, composed of Scots fir and larches alone, to give them air from below by lopping off the lower branches, especially of the Scots fir. The circumstances in which this process is desirable, very ordinary observation will point out.

REPORT ON THE ACT 9 AND 10 VICTORIA, CAP. 101, CALLED THE DRAINAGE ACT.

As this Act is a measure directly bearing on the interests of all the agricultural classes in the United Kingdom, from the proprietor to the labourer, and as it is believed that the nature of its provisions, and the interpretation which it will probably receive from the Commissioners, are as yet but imperfectly known, the Directors of the Highland and Agricultural Society have considered it to be their duty to give the measure their best and earliest consideration, so as to enable them to express to the Society an opinion in regard to it.

The Directors would premise, that were this measure at present before the Legislature, and therefore open to discussion as a subject of future policy, they would hold themselves precluded, by the rules of the Society, from entertaining it; but seeing that it is now the law of the land, having for its declared object the promotion of agriculture, they consider that it legitimately falls within the scope of their duty, to point out the nature and extent of its advantages, to explain the manner in which

they can be most readily realized, and respectfully to offer for consideration any suggestions, the adoption of which might give to these advantages additional effect.

The objects of the Act, as set forth in the preamble, are the increase of the productiveness and value of land by drainage, the employment of agricultural labour, and the improvement of the general health of the community.

To effect these most useful and important purposes, the Act authorises the issue by the Treasury, from the consolidated fund, of two millions for Great Britain, and one million for Ireland.

The Inclosure Commissioners for England and Wales are nominated the Commissioners for carrying the Act into execution in Great Brtain, and all applications from Scotland, for advances under the Act, must be addressed to them. The applications are advertised in the Gazette, and in a local newspaper; two months are allowed to elapse, and if in that interval any objection is stated by heritable creditors, or substitute heirs of entail, the applicant must obtain the authority of the Court of Session, which will be a sufficient warrant to the Commissioners to entertain the application.

When no objection is stated, the Commissioners at once direct an inspection of the land, proposed to be drained, to be made by an assistant commissioner or surveyor; and if they are satisfied with his report, they issue to the applicant a provisional certificate, declaring, that a loan shall be issued when the proposed works have been executed according to the plan and specifications lodged.

The Commissioners may order occasional inspections during the progress of the works.

On the certificate of the Commissioner or Surveyor, that the works have been completed, and that the amount, specified in the provisional certificate, has been expended, a warrant will be issued by the Treasury for payment. The loan bears interest at 6½ per cent for the period of twenty-two years, payment of which extinguishes the debt.

As different portions of the work are completed, an advance, to the extent of two-thirds of the value of the drainage executed, may be made to account of the sum in the provisional certificate; but if the different farms or townships, to be drained, shall have been separately specified in the schedule of application, then the whole of the expense of any specified operation, actually completed, will be paid.

The first question, which naturally suggests itself to a party desirous to avail himself of the provisions of such a measure, is —how far it will prove financially advantageous? The Directors have no hesitation in expressing their opinion, that the

terms, on which advances are offered, are favourable to the borrower. These are, that for twenty-two years the party obtaining the advance shall pay $6\frac{1}{2}$ per cent thereon. And if 4 per cent be taken as the ordinary rate at which he can borrow in the market, which is the least that he would pay at present, it is believed, that calculation will show him to be a gainer, and that at the end of the period of twenty-two years, the whole sum borrowed will not have been repaid by him. It is not, however, in this point of view only that the pecuniary benefit is to be considered; for there is the manifest advantage of accumulation, and consequent extinction of debt within a limited period, and this in a manner which country gentlemen cannot, under ordinary circumstances, command, while they are not exposed to the unavoidable expense attending the occasional transfer of securities, and termly payment of interest.

It may be objected that the landowner must, in the first place, make the entire advance; but this unavoidable difficulty may possibly be obviated by lodging the provisional certificate at a bank, as a security for an interim loan.

The next question which presents itself, is—how far these advantages are counteracted by the expense of the machinery, devised to secure them? The Directors are aware that many may be deterred from availing themselves of the boon offered, by the fear of becoming involved in a heavy expenditure in the first instance, and they are therefore happy to have it in their power to state, that, in their opinion, such apprehensions are unfounded.

Not only is the procedure indicated by the Act simple and economical; but the Commissioners are disposed to give effect to it in such a manner, as to subject applicants to the least possible expense.

The Directors are supported in this statement by the terms of a printed letter, addressed to proprietors in the distressed districts of the highlands and islands of Scotland, by Mr Blamire, one of the Commissioners. The Directors refer to that document with much satisfaction; for, though it cannot be regarded as the official communication of the whole Commissioners as a board, it may safely be read, as an exposition of the views entertained by Mr Blamire, and of the interpretation, which, he believes, his colleagues are disposed to give to the Act. The Directors have no hesitation in expressing their high opinion of the soundness and liberality of these views, which are in consonance with the spirit of the Act.

The only preliminary proceedings, creative of expense, (assuming the non-existence of objectors to the application) are the advertisements and the inspection of the land. The first step to be taken, is an intimation, by any landowner, of his wish to avail him-

self of the provisions of the Act, addressed to—"The Inclosure Commissioners of England and Wales;" on receipt of which they forward, for his execution, a simple form, specifying, when filled up, the particulars of his application. Notice of the application is then sent by the Commissioners to the Gazette and local newspaper, and an inspection of the ground is directed. The expense of the preliminary report, and of any subsequent investigation, is borne by the applicant; but Mr Blamire states, that "the Commissioners are most sincerely desirous of subjecting landowners to as small an amount of expense, for the superintendence of the works, as may be compatible with a proper discharge of their duty; and, with the view of doing so, they are disposed to select as their assistants, parties resident in the immediate localities of such works—assuming that parties competent and trustworthy can there be found."

The Directors have no doubt that competent and trustworthy inspectors can be found in every district; and they would suggest, with the view of diminishing the expense of the survey, that proprietors, in the same locality and district of country, who intend to make application, should do so simultaneously, so as to allow the Commissioners to nominate one surveyor, and to enable him to conclude the different inspections at one and the same time.

Mr Blamire's letter contains the following satisfactory announcement:—"With the view of enabling applicants to commence their works at once, and without waiting for the expiration of the two months prescribed by the eighteenth section, the Commissioners have decided that all works, done *after applications have been made for advances*, are works, done under the provisions of the Act, and that the cost thereof will be included in the estimate of the money to be advanced, assuming the works to be done satisfactorily, and that the contemplated drainage is not stopped by reason of objections taken thereto, by parties having charges on the lands in question."

The Directors believe that this announcement will induce and enable proprietors to commence at once certain portions of the operations embraced in their applications, and thereby to provide immediate work for the non-employed able-bodied persons in the country. But it is necessary that every proprietor, who may determine to take advantage of the facility thus afforded, for giving immediate employment to the labouring classes, should be careful to keep accurate accounts and vouchers for the sums expended. While noticing the necessary procedure to be observed, the Directors would further call attention to the circumstance, that in no stage of it are bonds exigible, except for the expense of preliminary investigation, should the Commissioners think it

necessary, and that when bonds are so used they are exempted from stamp duty.

Proprietors ought not to be deterred from applying for assistance, by any apprehension that they may be trammelled, in executing the drainage of their estates, by being compelled to observe any precise rules, or to follow any one system. On this point, the views expressed in Mr Blamire's letter are of the most distinct and satisfactory nature:—"With reference to the kind of drainage to be adopted, and to the manner of effecting the same, the Commissioners would not be disposed to object to any plan of drainage proposed; assuming that it was one which the party would have adopted had he been expending his own money, and assuming, also, that it was not manifestly an improper and injudicious one.

"The object of the Landowners and of the Commissioners must be identical; viz. that of effecting the greatest amount of improvement at the least cost—due and reasonable regard being had to the permanency of the works.

"The Commissioners are well aware that no one system of drainage is applicable to every case; on the contrary, they believe that each case should be dealt with as its peculiar circumstances and facilities may point out. On this head I will only further add, that I conceive the Commissioners may fairly be expected to be put in possession, within a short time, of such information as to the most efficient and inexpensive methods of draining every variety of soil, in every part of Great Britain, as to be capable of affording advice to those requiring it.

"Such advice and assistance they would, of course, be ever ready to afford, though, as I conceive, without presuming to insist upon its adoption.

"With reference to the drainage of cultivated lands, I will only remark that the depth of the drains, and their distance asunder, must necessarily depend upon a thorough knowledge of the subsoil, and of its retentiveness, which knowledge can only be acquired, in numerous cases, by actual proof of the results of comparative experiments on the same soil; no science or skill, as I believe, being equal to determine the relative retentiveness of different soils, unaided by practice or experiment.

"The adoption, too, of the material to be used for the drains, must and will depend upon the facilities for obtaining such materials, and their relative prices in each locality."

In another and important respect—the interpretation of the Act in regard to the drainage of uncultivated lands—the Directors must again recur with satisfaction to Mr Blamire's letter. That gentleman states—"With reference to the drainage of uncultivated lands, (of lands still in a state of nature,) it will often be found that

the first process must be that of getting out of the land, to a certain depth, all stones or portions of rock, by trenching such lands more or less perfectly; as well for the purpose of obtaining the materials for drainage, as of rendering the lands capable of being ploughed in the ordinary manner.

"The second process would be that of putting in the drains, and the third, that of fencing the lands when drained.

"Now, as to the first of these three processes, I can only say (in the absence of my colleagues) that I am individually of opinion, that such *Trenching* is an expense necessarily incident to the drainage of lands, and therefore clearly within the provisions of the Act; and that I have no doubt but that the Board will so decide.

"As to the third point, the *Fencing*, the Board have not as yet had any discussion upon it, and it is not a point which would appear to me to press for immediate decision; at the same time I may venture, I think, to state to you, that I have every reason to hope, and to expect, that the government will not withhold their sanction to this construction of the Act, such fencing being consequent upon the drainage of the land.

"With reference to the drainage of moss or bog lands, I will only state that I conceive, in many cases, the main drains would be made to answer the purposes of fences, and that no fencing, or but little, would be required in such cases.

"And lastly, it would appear to me, that by the drainage of many of your sheep walks, a vast improvement, both in the temperature of the climate and in the herbage of your pastures, might be effected."

The Directors agree with Mr Blamire, that trenching is a necessary accompaniment to the draining of uncultivated lands, which are to be rendered arable; and they have much satisfaction in thinking, that the provisions of the Act are to cover the expense of such an operation, which will be of great advantage in districts occupied by cottagers, by enabling them to increase the extent of their lots. The Directors are not aware whether the Commissioners may consider themselves entitled to sanction expenditure on fencing, but it is hoped that the measure will be so far extended, should a supplementary bill be brought forward. To the Highland districts in which the potato crop has failed, this is a matter of the highest importance. If these districts are no longer to depend on potatoes for the chief food of the inhabitants, the cultivation of grain must be largely increased, and much new land brought under tillage; for nearly three acres of oats or bear are required to produce as much human food as one acre of potatoes. These districts are all grazing countries, and in such countries no crops of any kind can be raised without secure fences.

The Directors, while expressing their approval of the objects of the Act, of the manner in which it is to be executed, and of the liberal views entertained by the Commissioners, would take the opportunity of offering a few suggestions for their consideration.

Mr Blamire states, that "the Commissioners make a point of directing the attention of applicants for advances, to the propriety (when practicable) of stating in their applications the sum required for the drainage of each farm or parcel of land separately, in order that, so soon as the drainage of such farm or parcel of land is completed, the whole amount assigned for such works by the provisional certificate (section 17) may be paid; otherwise, when the application refers to the drainage of more farms than one, and the provisional certificate assigns an aggregate sum for the drainage of these farms, the 17th section prevents an advance on account for works done, of more than two third parts of the sum then expended."

The Directors would suggest, that the Board of Commissioners should—after entertaining an application to cover the sum necessary for the whole of the drainage, contemplated on an estate or barony, and issuing a provisional certificate for the gross amount—thereafter receive, in the shape of a supplementary specification, the details of the expenditure to be made on each farm or township, in order to facilitate the payment of the full amount, so specified and expended on each separate piece of work. But it would be an additional boon to landowners, and give them increased facility in availing themselves of the benefit of the Act, if the advances "*on account*," referred to in sections 17 and 28, were extended from two-thirds to the whole of the sum covered by the provisional certificate; and the Directors would strongly urge these points for the consideration of the Commissioners.

In the event of another Act, it would be desirable that power should be given to all proprietors to claim the cost of the tail or outfall, as a proper part of the expense of drainage; and more especially that proprietors of upper lands should have a right of outfall, through adjoining and lower properties. The Irish Draining Act contains such a provision, and the introduction of a similar one for Scotland, under proper precautions for the protection of the proprietor whose land is to be used, would remove obstacles, which now present themselves to the drainage of many parts of the country.

The Directors would, in conclusion, express their decided opinion, that the Drainage Act confers a great boon on the landed interest generally, and more especially on proprietors holding their estates under settlements of entail, who, at present, can borrow money for such improvements only at a great sacrifice;

while, by the present measure, they may, with the aid of their tenants, (who, in most cases, will readily agree to pay a large share of the interest,) raise money at the ordinary market rate. It is also to be observed, that the interpretation which the Commissioners will, it is expected, put on the provisions of the Act, as well as the manner in which they are ready to give effect to them, materially enhance the advantages it affords.

These advantages are not confined to any one section of the agricultural class, but extend to the whole body; to the landlord and to the tenant, by holding out, in the absence of other means, a ready mode of improving their lands; to the labourer, by providing for him work and wages; and to the country, by increasing the productiveness of our native soil.

The Act recognises the right of a tenant to become a party to an application; and the tenantry of the country, especially those holding under current leases containing no clauses for drainage, cannot be too strongly impressed with the importance of availing themselves of the benefit of this measure, by co-operating, when necessary, with their landlords. In many cases the concurrence of a tenant may not be required; but in others, from the peculiar circumstances in which the estate may be placed, it may be unavoidable. The advantage of such co-operation cannot be better illustrated than by the following case, the circumstances of which are known to one of the Directors, and, with a statement of them, they will close this report:—Within these few days a farm was let under condition that the proprietor should expend a certain sum in cutting drains, the tenant filling them. After the bargain was concluded, the tenant proposed that the proprietor should avail himself of the provisions of the Drainage Act, and apply for double the sum to be so expended, on which he offered to pay interest at the rate of four per cent. To this proposal the proprietor at once agreed, and the effect of it is, that the proprietor will get double the sum he proposed, expended upon the permanent improvement of his estate, for payment merely of an annuity of 2½ per cent for twenty-two years.

REPORT ON THE IMPROVEMENT OF WASTE LAND ON THE FARM OF PARKTON, IN THE PARISH OF KILLEARNAN AND COUNTY OF ROSS, BELONGING TO COL. H. D. BAILLIE OF REDCASTLE, M.P.

By William Dick, Tenant.

[Premium, Silver Medal.]

Having entered to the farm of Parkton, containing seventy acres of arable land, in 1838, and after putting it into good order, my attention was directed to the improvement of a piece of waste land, which stretched in a continuous line along the north-east side of the farm, with the exception of a few patches to the south. I have altogether improved fifty acres, of which above thirty acres have been brought under the plough during the last three years.

The ground was formerly under fir-wood, which was cut and sold about twelve years since, with the exception of a few acres, which are still standing. The surface was generally covered with short stunted heath, the pasturage on which was probably not worth more than 2s. per acre. The soil was a clayey gravel, in some places inclining to peat, on a subsoil of wet clayey gravel.

The ground was trenched twelve inches deep, with the exception of three acres which were taken in with the plough, and about twenty-five acres were partially furrow-drained, at eighteen and twenty-four feet apart, according to the retentive nature of the subsoil. Large open drains were made to subdivide the ground into fields.

The expense of these improvements was as follows:—

Trenching twenty-eight acres, at £6 per acre,	£168	0	0
Ploughing three acres, and taking out roots,	6	0	0
Clearing the ground of roots, stones, and levelling,	62	0	0
3353 yards of large covered drains, at 2d. per yard,	27	18	10
2975 do. of large open drains, at 1½d. per do.	18	11	10½
20,398 yards of furrow drains, at 1d. per do.	84	19	10
Total,	£367	10	6½

Making an average cost of £11 : 17 : 1 per acre.

The first crop was taken in 1843 from about ten acres, which were well limed, and manured with farm-yard dung, and sown with barley, which yielded a pretty fair crop of about four quarters per acre. In the following year, 1844, this ground was pastured. In 1845 it was broke up for oats, which yielded a very fair crop, probably five quarters per acre. The remaining twenty acres were prepared for oats in 1844 by manuring and liming, and the

crop was a fair one, at least five quarters per acre. In 1845, this portion was under turnips and potatoes—the potatoes being a good crop, but the turnips were below an average.

REPORT OF EXPERIMENTS IN DEEP PLOUGHING.

By J. Wilson, Eastfield, Penicuik.

[Premium, Silver Medal.]

It has long been a matter of dispute amongst practical farmers to what extent deep ploughing ought to be practised, some arguing that it is at all times preferable to plough shallow, as it is easier to keep a small quantity of soil than a large one formed by deep ploughing in a fertile state; others again aver, that by shallow ploughing the land will annually become more shallow as long as it is under cultivation, and maintain that, whatever is the nature of the soil, deep ploughing ought to be performed at least once in the rotation. Each of these opinions has its advocates, and, I believe, in different localities may be correct. Thin, light soils, with a poor and barren subsoil, may for a time be rendered totally unproductive by intermixing too large a portion of the subsoil with the surface; while, on the other hand, in order to maintain the properties of a deep soil in a perfect state, it will be found expedient to plough it from time to time to the full depth of the vegetative stratum, to enable the roots of plants to penetrate into the ground, and likewise to expose them freely to the influence of the atmosphere. But assuming that a large quantity of new subsoil may be poison to one soil, while it may suit another, the practical farmer, unless he be a man of science, has no sure criterion to determine the propriety of the experiment. But, with the introduction of thorough-draining, a new era has commenced in this system of cultivation. A great variety of improvements have followed, but certainly none is more important than subsoil ploughing. Besides being a valuable auxiliary to furrow draining by breaking up the tenacious till, and allowing the water to escape into the drains, it likewise enables the farmer, during the course of cultivation, to mix small quantities of the virgin earth of the subsoil with the surface, which, little by little, gradually tends to increase the depth of the vegetative mould—a plan certainly more judicious than that practised by those who advocate the cause of shallow culture to save manure, and I suspect in most cases more expedient than at intervals to bring up

large quantities of the under stratum to improve the exhausted soil.

Being convinced of the advantage to be derived from subsoil ploughing, I would humbly relate the results of a few experiments made in 1845.

The farm upon which these experiments were made has been under cultivation for a long period; it is nearly level, with a north exposure, exhibiting various kinds of soil, from a gravelly earth to a tenacious clay. It had for a great number of years been ploughed at the depth of from five to six inches without any extra deep ploughings, and a hard crust had formed at that depth, which in some of the fields was almost impenetrable to the plough. Within the last few years a considerable portion of the farm has been furrow drained, the valuable effects of which in some of the fields were greatly hindered by the retentive nature of the subsoil, the hard pan or crust formed beneath the action of the plough being nearly impervious to water. On one or two of the fields which were of deep earth, trench ploughing to the depth of thirteen inches was performed with good effect; but, from the nature of the subsoil of the rest of the farm, we thought it inexpedient to perform this operation, more especially as most part of it had been recently limed. We accordingly commenced in the autumn of last year, 1844, and subsoil ploughed to a considerable extent, and have not been disappointed in the effects produced. The subsoil plough, from its great weight, I conceive, cannot be expected in many districts to be much used, as it requires a greater number of horses to wield it than is kept on many farms; but, as a strong iron plough drawn by two horses has been found to answer equally well, at least where the subsoil is not very tenacious, subsoil ploughing may be performed any where at a trifling expense. When the farmer is not in possession of a plough made for the purpose, he has only to take away the mould board from one of his iron ploughs, which he can replace at pleasure, and it will answer his purpose; but the expense of having a plough made for executing the work effectually is trifling, compared to the benefit to be derived from the operation.

The first field experimented upon contains thirteen imperial acres; the soil is rather variable, the most part being heavy, inclining to clay, upon a clay subsoil, and the rest is a light soil upon a gravelly subsoil. It was drained when in clover lea, in the autumn of 1843, with tiles at fifteen feet apart, and a crop of oats taken in 1844, and, previous to draining, it was exceedingly wet, and almost proverbial for bearing bad crops. We commenced to subsoil it about the middle of October, and finished it about the 10th of November; it was performed across

the drains, the common two-horse plough going first, taking a depth of six or seven inches, followed by the subsoil plough with two horses; taking an additional depth of from seven to eight inches. This operation was performed upon eleven acres of the field, and two acres were ploughed at the ordinary depth of six and a half inches, extending from side to side of the field. In preparing it for the green crop in the spring of the present year, we found the difficulty in getting below the hard crust or pan completely removed, and the soil could have been wrought to any depth required with the greatest ease. We preferred ploughing it, however, at the depth of seven inches. The whole field was manured in the drill with a moderate supply of farm-yard dung and guano, and sown with yellow turnips between the 1st and 13th of June. The turnips brairded regularly, and of course a better season for testing the value of furrow draining and subsoil ploughing could not have occurred, the continuous rains rendering the turnip crop on undrained lands comparatively deficient.

The turnips on the portion which was ploughed in the ordinary way brairded equally well as the others, nor was there any visible difference till about the beginning of August, when those upon the subsoiled land became decidedly superior, and continued to make rapid progress till lifted on the 28th of October, when the result was found to be as follows:—

Treatment received.	Quantity per Acre.	Value per Ton.	Value per Acre.	Excess from Subsoiling.	Value of Excess.
	Tons. Cwt.	s.	£ s. d.	Tons. Cwt.	£ s d.
Subsoiled	26 17	12	16 2 2¼	6 10	3 18 0
Not Subsoiled.	20 7	12	12 4 2¼	... ...	... ...

The increase from the subsoiling may, no doubt, be partly attributable to the wetness of the season; but this of course solves the problem, that furrow draining is comparatively deficient without the necessary auxiliary of subsoil ploughing; and I am strengthened in my conclusion, that it is more judicious to stir up the subsoil with the subsoil plough, than to bring too large a quantity of it to the surface by deep or trench ploughing, by the fact, that, on a farm immediately adjoining, a field of nearly the same quality, which had previously been furrow drained, and had been undergoing nearly the same treatment, was ploughed last autumn, in preparation for the green crop, to a depth of ten or eleven inches, and although well pulverised by the winter's frost, and a liberal quantity of manure supplied, the crop was nearly a complete failure.

The next experiment was made upon a field which was furrow drained with tiles, at fifteen feet apart, in the autumn of 1844. The field has a gentle declivity, with a north exposure, the soil a deep earth, rather inclined to sand, upon a subsoil of sandy clay. Two acres were subsoil-ploughed to the depth of fifteen inches, in December last, and other two were ploughed six or seven inches; and to prove the effect of trench and subsoil ploughing upon this kind of soil, two ridges were trench-ploughed to the depth of thirteen inches. The field was ploughed across in spring at the usual depth, and manured with farm-yard dung in the drill, and planted with potatoes between the 3d and the 6th of May. The subsoiled portion had the best appearance during the season, and on lifting the crop on the 22d and 23d of October, we found this experiment to give the following result:—

Treatment received.	Quantity of Potatoes per acre.			Value per ton.		Value per acre.			Excess from subsoiling and trench ploughing		Value of excess.		
	tons	cwt.	qrs.	£	s.	£	s.	d	cwt.	qr.	£	s.	d.
Trench ploughed	7	1	2	2	5	15	18	$4\frac{1}{2}$	7	1	0	16	$3\frac{3}{4}$
Ploughed	6	14	1	2	5	15	2	$0\frac{3}{4}$	...	...	...	...	
Subsoiled	7	9	2	2	5	16	16	$4\frac{1}{2}$	15	1	1	14	$3\frac{3}{4}$

Another experiment was made upon a field intended for barley after potatoes. It was partially drained a number of years since, and the soil is an earthy loam incumbent on clay. A portion of this field was subsoil-ploughed about the 10th of November, and the remainder ploughed at the ordinary depth. The barley was sown about the 1st of April, and the subsoiled portion kept the lead in point of strength throughout the season. The crop was cut on the 22d of September, and when thrashed the results were found to be as follows:—

Treatment received.	Quantity of Barley per acre.			Quantity of Straw per acre.	Weight of Barley per bushel.	Value of Barley per quarter.	Value of Straw per cwt.	Value of Barley per acre.			Value of Straw per acre.			Excess of Barley per acre.		Excess of Straw per acre	Value of excess of Barley per acre.			Value of excess of Straw.			Value of excess of Barley and Straw		
	qr.	bsh.	pks.	cwts	lbs.	s	s	L	s.	d	L.	s.	d.	bsh.	pks.	cwt	L.	s.	d	L.	s.	d	L.	s	d.
Subsoiled,	8	3	...	$36\frac{1}{2}$	$51\frac{3}{4}$	30	3	12	11	3	5	9	6	6	1	$8\frac{1}{2}$	1	3	$5\frac{1}{4}$	1	5	6	2	8	$11\frac{1}{4}$
Not subsoiled,	7	4	3	28	$51\frac{3}{4}$	30	3	11	7	$9\frac{3}{4}$	4	4	0	...	...	...	......			......			......		

On examination it will be found, that when not prevented by the tenacity of the subsoil, the roots of grain strike into the earth to a considerable depth; and of course when cultivation is

confined to only five or six inches from the surface, the roots have to contend for their share of nutriment; the strongest, of course, may be expected to deprive the weakest of nourishment, and which, no doubt, may account for the crops upon certain shallow wrought soils being invariably thin. In this experiment the increase would probably have been greater, had the crop not been lodged long before it came to maturity.

Another small experiment was made when ploughing a field of clover-lea, in February last; the soil inclined to clay, with a stiff clay subsoil, not drained. The field was ploughed at the depth of 5½ inches. Only two ridges were subjected to subsoiling to the depth of twelve inches. This experiment proved to have no beneficial effect, the crop rather thin throughout the season, and, as I did not get the produce thrashed separately, I could not obtain the result, but it appeared to be rather deficient. But, of course, I would question the propriety of performing this operation for a grain crop, when the ground is in lea, as there is a considerable difficulty, when the subsoil plough is at work, in laying the furrows so compact as they ought to be for the reception of the seed, and in general cases I think it ought to be performed in the autumn previous to fallow or green crop.

In concluding this short detail of experiments, I would only add, that from the experience I have had, I assume that deep or trench ploughing may be performed advantageously, generally on deep soils, while it may be detrimental to thin soils, resting on sterile or tenacious subsoil; but that subsoil ploughing will seldom be found injurious if judiciously performed, and that a great variety of soils, after furrow draining, will be much benefited by the operation.

EXPERIMENTS ON THE RIPENING OF OATS.

By Mr Alexander Murray, Nether Mill of Cruden, Aberdeenshire.

The objects in view in making these experiments were,

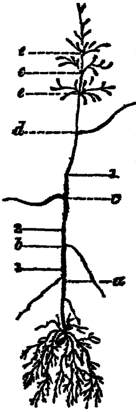
1st. To discover and determine from certain uniform appearances, how the stages to maturity might be recognised upon examination of the stem and leaves.

2d. To ascertain the difference in the samples reaped at these stages toward maturity.

1. In the first instance, I selected specimens of stems from the

same variety of oat, viz. early or English barley, growing on similar quality of soil. After a careful examination of many such specimens, at and posterior to the time in which the milky state of the ear had become hard, yielding very light grain, I was agreeably surprised to find that *six* stages to maturity might be readily discriminated, and that the sample afforded at each stage was of uniform ripeness, and might easily be distinguished from any of the others in respect of maturity.

Referring to the figure, *a*, *b*, *c*, *d*, represent the four uppermost leaves on the stalk; *e*, *e*, *e*, where the branches of the panicle join the stem; and 1, 2, 3, the three uppermost joints of the stem.



The *first* stage I fixed upon was when the leaf *a*, situate immediately below the lowest or 3d joint of the stem, and fourth leaf counting downward from the ear, had assumed a yellow hue, while those above it were yet green.

The *second* stage was when the third leaf, *b*, below the 2d joint, became yellow, and those above it yet continued green.

The *third* stage, when the second leaf, *c*, below the 1st joint, was yellow, and the one above it continued green.

The *fourth* stage, when the first leaf, *d*, situate between the ear and the 1st joint, became yellow.

The *fifth* stage, when the parts, *e*, *e*, *e*, where the branches of the panicles join the stem, were alone green.

And the *sixth* stage was when the greenness had entirely disappeared.

2. I next found that the samples of grain produced at the above six stages were easily distinguished from each other by appearance and quality.

I submitted them on several occasions to competent judges, who were able at once to arrange them in their proper order; and they agreed that there was a difference in weight of 1½ to 2 lbs. per bushel between the samples produced at the *fifth* and *sixth* stages.

RETURNS to the HIGHLAND and AGRICULTURAL SOCIETY of SCOTLAND of COMPETITIONS in SEED for CORN and other CROPS, held in the Year 1846.

Districts.	Seed Exhibited in Competition by Growers to whom Silver Medals were awarded. Names of Species and Varieties.	Quantity. Qrs.	Number of Competitors.	Sum Total of Awards. L.	s.	Competitors to whom Silver Medals were adjudged. Christian Name and Surname.	Estate or Farm, and Post-town.	Produce per Imperial Acre. Qrs.	Weight per bushel. lbs.	oz.	Date of Sowing.	Date of Reaping.	Ground on which the Prize Seed was Grown. Altitude. Feet.	Exposure	Nature of Soil.
District of Dalkeith.	Potato Oats, ...	10	3	2	0	Alex. M'Dougall,...	Granton Farm, Wardie, Edin.	Not ascertained.	44	8	March 28, 1845	Sept. 7, 1845	100	N.	Strong loamy clay, drained.
	Hopetoun Oats, ...	10	2	2	0	Robert Cross, ...	Hilltown, ...Dalkeith, ...	$6\frac{1}{2}$	42	0	April 10, ...	Sept. 15, ...	167	N.E.	Between a free and stiff soil, do.
	Barbachlaw Oats, ...	10	1	2	0	George Watson, ...	Libberton Mains, Libberton,...	8	40	8	March 17, ...	Aug. 26, ...	160	N.	Light, not drained.
	Early Angus Oats, ...	10	10	2	0	John Gibson,........	Woolmet, ...Dalkeith, ...	$7\frac{7}{8}$	43	0	March 26, ...	Sept. 2, ...	170	S.	Light Loam.
	Late Oats, Grey Angus,	10	5	2	0	John Rate, ...	Milton, Salton, Haddington,	4	42	8	April 4, ...	Oct. 14, ...	3 to 400	N.	Moorish, partly dr.
	Chevalier Barley,.........	10	4	2	0	John Bagrie,.........	Millar Hill,.........Dalkeith, ...	8	56	8	March 26, ...	Aug. 29, ...	160	E.	Rich loam, drained.
	Scotch Barley, ...	10	3	2	0	Robert Cross, ...	Hilltown, ...Dalkeith, ...	$6\frac{1}{2}$	56	0	April 24, ...	Sept 1, ...	150	S.E.	Free—inclining to black loam, dr.
	Hunter's Wheat, ...	8	2	2	0	Robert Cross, ...	Hilltown, ...Dalkeith, ...	$1\frac{1}{2}$	62	0	Nov. 5, ...	Aug. 11, 1846	160	S.E.	Light, undrained
	Pearl Wheat,...............	8	7	2	0	John Shand, ...	North Elphinstone, Tranent,	about 4	63	4	March 9, 1846	Sept. 3 or 4 ...	300	Nearly level; but inclining to east.	Rather heavy, drained.
	Red Seed Wheat,.........	8	3	2	0	Robert Cross, ...	Hilltown, ...Dalkeith, ...	4	63	0	Nov. 15, 1845	Aug. 14, ...	160	N.	Inclining to heavy, thoroughly furrow drained,
County of Nairn.	Common Barley, ...	3	3	2	5	Wm. Mackintosh of Geddes, ...	Nairn,.........	5	58	0	April 17, ...	Sept. 3, 1845	100	N.W.	Black loam, undr.
	Late Oat, Grey Angus,	3	3	2	5	James Mackillican,	Piperhill, ...Cawdor,......	5	45	$9\frac{1}{2}$	March 20, ...	Sept. 12, ...	120	N.	* do. do.
	Early Oat, Sandy, ...	3	4	2	5	Wm. Mackintosh of Geddes, ...	Nairn,.........	$5\frac{1}{2}$	46	14	March 29, ...	Sept. 4, ...	110	N.W.	† do. do.
	Perennial Ryegrass, ...	2	2	2	5	David Rose, ...	Newton,............Cawdor,......	...	25	15	... ...	... ...	120	Level.	Light alluvial soil.
	Oxford White Wheat,	3	7	2	5	Wm. Mackintosh of Geddes, ...	Nairn,.........	4	66	5	Nov. 2, ...	Aug. 12, 1846	150	N.	Black loam on gravel, undrained.

* First Crop after two years old lea. † First Crop dressed with 2 cwt. Guano per acre.

HIGHLAND AND AGRICULTURAL SOCIETY'S HALL,
EDINBURGH, *November* 1846.

By Order of the Directors,

JN. HALL MAXWELL, *Secretary.*

SUPPLEMENTARY REPORT TO THE DIRECTORS BY THE COMMITTEE ON THE DRAINAGE ACT.

It is unnecessary to occupy the attention of the Board by any lengthened Report on the alterations and amendments previously suggested. They are noticed in the printed Report, and, as was stated to the General Meeting, they have been approved of by the Commissioners.

They had reference, 1st, To a diminution of the expense involved in the production of plans, specifications, and estimates, and in the subsequent superintendence of the works.

2d, To payments on account of the whole, instead of two-thirds of the sums expended, as portions of the works are completed.

3d, To the recognition of trenching, as, in some cases, accompanying the draining of lands previously uncultivated, or in a state of nature, which are to be rendered arable.

4th, To a provision for a right of outfall through adjoining and lower properties.

Since these points were under consideration, others have emerged, which, in the opinion of the Committee, require the serious attention of the Board, with the view of being brought under the notice of the Commissioners.

1st, When the outfall is formed by a stream, or the centre of a marsh, constituting the boundary between two conterminous properties, and when such outfall requires to be deepened, straightened, or otherwise altered in its level or course, the Committee would suggest that an amended Act should confer special power to apply, with the consent of the Commissioners, to the Judge Ordinary, (the Sheriff of the county, or his substitute,) to authorise the operation to be proceeded with, and to assess the amount of compensation, which shall be made if possible in land, and, where that cannot be accomplished, in money.

2d, When it is necessary, in order to secure a proper outfall, to take away or interfere with the exercise of any right of water-power, previously used only for meal or thrashing-mills, or other agricultural purposes, similar power should be conferred to apply, with the consent of the Commissioners, to the Judge Ordinary, to authorise the necessary steps, and to provide for compensation, to be given by means of another supply of water, or in money.

3d, When, for the purposes of the outfall, it is necessary to carry the operations either above or under the boundaries of the lands in course of being drained, similar power should be given, with the consent of the Commissioners, to the Judge Ordinary, to authorise and direct the operations to be undertaken

at the expense of the applicant, and to assess the compensation on account of any water-power previously used for agricultural purposes, which may be affected by them, providing, however, that the owner of the lower property shall be bound to support and maintain such outfall after it has been formed, on a proper adjustment of the expense thereof, among the parties benefited.

4th, The 36th Section of the Act provides, that advances under it shall not be deemed a contravention of the conditions of an Entail; but there is no similar provision to secure heirs of entail, who have obtained private Acts, containing a prohibition against burdening their estates for improvements. It may therefore be necessary to provide that advances may be applied for, and received under the Act, "notwithstanding the provisions of any private Act or Acts of Parliament relative to such entail."

5th, It would confer an important boon on Entailed Proprietors, and give them increased facilities of taking advantage of the Act, in co-operation with their Tenants, were they empowered to void existing, and grant new leases, for the period of twenty-two years, of lands to be drained under the Act, notwithstanding the provisions of any Entail or law to the contrary.

6th, When parties hold provisional certificates, in security of interim advances made on account of operations under the Act, it is desirable that their right to apply for payment of the sum contained in the certificate should be recognised by the Government.

7th, As payment can only be required from Government on account of works which have been completed, it is important that some provision should be made to protect holders of provisional certificates, in the event of the decease of a borrower, and the refusal of his heir to complete operations unfinished at the time of his death. This might be effected, either by making it obligatory to complete improvements commenced under the Act, or, when the Proprietor declines to do so, by empowering those having right to his provisional certificates to proceed, so as to enable them to recover from Government the amount of advances made by them.

8th, The Committee are, lastly, of opinion, that the application of loans should be allowed to extend over a period of five years, to enable Proprietors to drain, as lands may be broken up in the regular rotation of cropping, which in Scotland is generally the five crop shift.

The Committee would, in conclusion, urge the advantage of these provisions being embodied in the Act itself. The machinery required for giving effect to them will be simple and easily supplied, and they think that an amended Act would be incomplete, and in many instances inoperative, without it, while the success of a separate measure supplying these essentials may be problematical, and in any event attended with delay.

MANUFACTURE OF IODINE AND THE VALUABLE SALTS OF KELP.

By Mr EDWARD MELDRUM, Mill Wall Chemical Works, London.

[Premium, The Gold Medal.]

To extract iodine, chloride of potassium, sulphate of soda, &c., economically from sea-weed, it must first be burned into kelp, the bulk and nature of the fuci not allowing its lixiviation readily without doing so; this part of the process will be treated of when we come to the evaporation of the kelp liquid. The kelp is broken into small pieces by hammers, about the same size and in the same manner as stones are broken for the roads, put into large cast-iron vats, and water run on it. See the vats, figs. 1, 2, and 3, Plate VII. A filter made of straw, dried sea-weed, or small stones covered with a mat is placed in each vat at *m* and B. Supposing the vats had been working. and A 4 to be newly filled with broken kelp, the plug holes *m* being all stopped, and also the communication B C betwixt A 1 and A 4, fig. 1, water is run on to A 1; it descends through the kelp in that vat and flows over by the pipe B C, into A 2, from A 2 into A 3, and from A 3 into A 4; as soon as this one is full the water is stopped running into A 1, allowed to stand for twelve hours, and run off by the hole *m*, in A 4, into the spout G M, which carries it into the receiver K, sunk into the ground, from which it is pumped up (see *n*, fig. 2) into the boiling pans. As soon as the liquid in A 1 falls to 5° Twaddel's hydrometer (sp. gr. 1.025) the hole *m* in A 1 is opened, and the weak liquid run into the receiver K, the vat is emptied of the insoluble matter of the kelp, and refilled with new kelp. The communication betwixt A 1 the strongest, and A 2 the weakest vats, is now stopped, and the weak liquid which was run into the receiver is pumped upon A 2, from which it flows round to A 3 and A 4 into A 1, from which, after standing twelve hours, it is drawn off by the hole *m;* and so on each vat is filled and emptied alternately, the new kelp always taking the place of that which is exhausted. In the present iodine manufactories the weak liquid, namely all below 20° Twad. (sp. gr. 1.100) is pumped upon the new kelp, but by this means that expense of labour is saved, as also a considerable quantity of fuel, on account of there being no weak liquors to evaporate. At first the liquid will stand 50° Twad. (sp. gr. 1.250,) and by the time the last of the four vats is exhausted, the strongest will have fallen to 35° Twad. (sp. gr. 1.175,) which is the weakest lixivium required to be concentrated. By having more vats connected with each other it may be kept stronger even than 35° Twaddel.

The filters may be lifted and renewed at the fifth operation.

The pipes B C should be straight, so as to allow them to be readily cleansed by an iron rod when they get stopped; and the end C should not be placed at the top of the vats, but about four inches from it, on account of the liquid requiring pressure in the first to send it round to the fourth vat.

The exhausted insoluble matter of the kelp is sold to green glass bottle-makers, but is often given to them for the carting of it away.

The kelp liquid, from 35° to 50° Twad. is pumped into evaporating pans, and concentrated to 60° Twad. (sp. gr. 1.300,) at its boiling point; during the concentration, a considerable quantity of sulphate and muriate of soda falls, which is regularly lifted and placed into a wooden or iron vessel filled with holes, set on the top of the boiling pan, so that the liquid which drains from it may run back:—See fig. 4, which is a side view of the pan and building for burning coals commonly used; fig. 5, a front view, and fig. 6, a plan of the top of the same, showing how they are generally set up with one common flue leading to the chimney. A are the pans, B the fireplace, E the ash-pit, C the flue which goes round the pan, G the flue which leads into the common flue D, *m n* iron binders to keep the arch of the fireplace from falling in. If the fires were placed under, as in the iodine retort fig. 12, Plate IX. instead of at the sides of the vessels, the salt which falls during the evaporation of the liquid would stick to the bottom; and that part underneath the salt getting red-hot, would inevitably crack, therefore the salt must be regularly scraped down from the sides where the flue and fireplace are, to the bottom, till there is a quantity of it gathered together, and then lifted into the drainer by a scoop pierced full of holes, and having a long handle fitted into it.

Fig. 7, Plate VIII., is an evaporating pan built up for saving more of the heat, by having the flue going twice round it, in which the kelp liquids could be concentrated economically with peats for fuel, of which an inexhaustible store abounds in the Highlands and Western Islands of Scotland; D is the pan, A the fireplace made larger than is necessary for burning coals, B the lower flue, from which it rises at the back of the pan into the upper flue C, and again goes round the pan.—See fig. 8, in which the upper flue is supposed to be lifted up by the front and laid back beside the under-flue at the place where the two join, the direction of the arrows showing the manner by which the flues lead the heat round the pan twice; thus allowing much less of it to pass into the chimney. Fig. 7, O is the flue leading down into the common flue G, made flat for the purpose of drying peat upon the top of the arch. By covering it with iron plates more heat could be saved for the purpose, than by covering it with an arch of bricks.

The process of making kelp, as at present carried on, being to burn the dried sea-weed in a sort of coffer, the heat evolved during this process would be the most economical method by which

the kelp liquors could be evaporated. This could not be done in a common fireplace, on account of the kelp melting into a mass, and also because a considerable quantity of the dried sea-weed requires to be together before it will burn properly. In the following construction of a furnace these objections are avoided, at least the melting of the burnt sea-weed is of no consequence here, as it cannot stop the current of air. See fig. 9, where A is the kiln into which the dried sea-weed is thrown by the hole C; the kiln has two doors, E, one at each side, opposite each other, for the purpose of removing the kelp; they should be built up with large stones or lumps of kelp placed loosely on each other, for the purpose of allowing a current of air to pass through the interstices; *m*, additional holes for this purpose, and also for stirring up the burning materials by; B, the flue which leads the heat round the pan D. It is evident several pans could be placed at each side of the kiln, each having a separate flue; but if there is only one pan there will require to be, besides its flue, one leading direct from the kiln into the chimney; in fact, there would better be this provision, although there were several pans, for the purpose of carrying off the heat as soon as the kelp liquid reaches its point of concentration. The flue B, being shut by the damper *n*, the damper of the flue leading direct into the chimney is then opened, or else the heat led off round other pans. The use of the flue, if there were several pans, would be in case of the liquor in the whole of the vessels being concentrated at the same time. The hole C should be provided with a door. If there were not more than two pans built at each side of the kiln, they could also be provided with fireplaces at X, (the damper *n* being then closed,) for the purpose of burning peat, if the supply of dried sea-weed run done, or the kelp gathered in stock. These fireplaces, when burning sea-weed is in the kiln, could be simply shut off in the same manner as the heat is shut off from the kiln by the damper *n*, the same flue answering for either. See fig. 4, Plate VII.; *s* being the damper placed here only for the purpose of showing how all com munication from the fireplace could be cut off. When peat or coals are burnt, the dampers for regulating the supply of air should be placed at the back of the pans, as at O, fig. 4. Sea-weed, or a store of peat, could be dried on the arch of the kiln, or the arch of the flues, G, made broad for this purpose, as in fig. 7, Plate VIII. If the kelp liquid is concentrated in this manner, it will be found more economical to work the pans night and day, and then no heat will be lost.

The manner of separating the muriate of potash from the sulphate and muriate of soda will now be explained; the concentration of the liquor being carried on by either of the means mentioned. The salt which falls, during the evaporation of the liquid

from the kelp, is drained as already explained, and put back upon the strongest vat, because it contains a considerable quantity of muriate of potash. The liquor concentrated to 60° Twaddel, after settling one hour, is laded or run off by a syphon into any sort of iron vessel to cool; wooden tubs could be used for this purpose, but iron will be found preferable and cheaper through the course of a few years. The muriate of potash crystallises on the sides of the cooler. It in general requires five days to cool, and is known to have all crystallised by the scum which formed on the surface of the liquid falling to the bottom. The liquid is now run out of the cooler into a receiver, and pumped up into the evaporating pans. A basket or wooden vessel filled with holes is placed on the top of the cooler; into which the muriate of potash is put and allowed to drain for twenty-four hours. The second liquid to be evaporated is boiled to 68° Twad. (sp. gr. 1.340) at its boiling point, during which a large quantity of salt is lifted out of the pan, composed principally of sulphate, muriate, and carbonate of soda. The boiling liquid is allowed to settle for an hour, and run into the cooler, when a second crop of crystals of muriate of potash falls. It is again run off and evaporated to 74° Twad. (sp. gr. 1.370;) at its boiling point, more sulphate, muriate, and carbonate of soda are got from it during its evaporation, and when run off and cooled, a third crop of muriate of potash crystallises, which is lifted and drained in the same manner as the first and second. During the evaporation of the first liquor from the kelp, the pan is constantly fed while it is boiling, by more kelp liquid, in small quantities at a time. The second boiling is fed by second liquor, namely, that from which one crop of muriate of potash has been got; and the third boiling in the same manner by third liquor, from which two crops have been got—these different liquids never being mixed. Soda ash, containing from 28 to 32 per cent of pure soda, can be made from the salt which falls during the evaporation, by fusing it in a reverbatory furnace in the usual way of manufacturing soda, with limestone and small coals (dross;) but this process could not be carried on without a large consumption of coals, and is therefore unsuited to the Highlands. Iodine manufacturers now generally sell this salt to soap-makers, not considering it worth their trouble to make it into soda ash, (this article having fallen in price lately,) which would also be the most economical way of doing with it in the Highlands.

The crystallised muriate of potash is purchased for the manufacture of alum; potash and carbonate of potash could be made from it, but this process would require a large quantity of coals, limestone, and sulphuric acid, with a ready market for the resulting muriatic acid, all of which would be against this manufacture in the Highlands. The most economical method of disposing of

this article is to sell it to the alum manufacturer, in which way a ready market can always be found for it.

If a more simple process in the evaporation of the kelp liquid is wished for, it being intended that each small manufacturer of kelp in the Highlands is to carry on the extraction of its salts, it would be much more simple, with less trouble and outlay of capital for coolers, to evaporate the liquid to 74° Twaddel (sp. gr. 1.370) at once, when the whole of the salts can be lifted out of the pan mixed together; the remaining liquid may then be evaporated to dryness, and either sold or sent to have its iodine extracted; but this will yield much less profit, as a less price will be got for the salts mixed together than separate. However, as the use of the hydrometer could be made very simple by having one for each boiling with only one mark on each, namely, at 60°, 68°, and 74°, as stated, each district could extract and separate the salts, the fourth liquor, namely, that which is drawn off the third crop of crystals of muriate of potash, being carefully evaporated to dryness and sent off to one common place, where the iodine could be extracted by a competent person, or else sold to the iodine manufacturer. To extract the iodine from the fourth liquor, (the salt obtained from this liquid, if evaporated to dryness, must be dissolved amongst water,) it is put into a wooden vessel and saturated with sulphuric acid not stronger than 140° Twad. (sp. gr. 1.700) which can be done correct enough for the purpose, by lifting a little of the liquid out, adding a few drops of sulphuric acid to it, and noticing if there is much or any effervescence; this test-acid should be very weak, and when added to the liquid saturated with sulphuric acid, it ought to produce no effervescence. In fig. 10, Plate VIII. A is the tub and B a leaden vessel placed on the top, from which the sulphuric acid is slowly run by a small lead syphon. If the sulphuric acid is much stronger than 140° Twad., violet-coloured vapours of iodine will rise where the two liquids meet, and thus be lost; the liquid should also be frequently stirred during the time the sulphuric acid is running in.

The liquid, after saturation, is allowed to stand for one or two days, till the sulphur produced by the mutual decomposition of sulphurous and hydro-sulphuric acids gather on the top. The sulphur is washed with water, (the washings being put back into the tub,) and can either, by the usual process of burning, be made into sulphuric acid, or sold for this purpose; the quantity produced is a mere trifle. The iodine retort is three-quarters or four-fifths filled with the saturated liquor. See this retort, figs. 11 and 12, Plate IX; A, a cast-iron pan, G, the fireplace, from which the flues, O, proceed round the pan; X X X, three lead pipes which lead off the iodine vapours into the eighteen condensers, S. The pan is covered with a leaden top, fig. 13, where A is the pan, B C the lead cover, with a man hole in its centre to allow the pan to

be cleaned; D, the cover for this man hole, with four holes in it, three of which are for the lead pipes, and the remaining one, E, (provided with a leaden stopper,) for putting in manganese by— *m n*, figs. 11 and 12, are two iron bars laid across the pan, round which pass lead straps, soldered to the leaden cover of the pan, to prevent its sinking down. Lead pans are often used for the iodine retort, put into the inside of an iron one, with sand between; but the iron pan itself will be found more economical, both in outlay and saving of fuel, and will last as long as a lead one, the liquid never being super-saturated with sulphuric acid; if it is so, both the pan and iodine will be wasted, as the quantity in this manner cannot be produced. All the joints of the retort-covers are made tight with clay, also the joints at the bottom of each receiver; these receivers are stoneware bottles, the half of the bottom of each coming off, and provided with a hole in the centre, into which the neck of another is inserted; fig. 14 being a view of the bottom of one of them with its corresponding half; fig. 15, another form of a condenser made of flag-stones, which will be found an improvement on the bottles at present in use, as there is not the quantity of joints in it to make tight, no danger of its breaking, and will be found to do the work as effectively: A B C D, is the condenser, fitted with two shelves, *r s* and *h s*, (also stone flags,) grooved into its sides, thus securing a large extent of surface for the iodine vapours to come in contact with, as seen by the direction of the arrows in the figure, whilst the condenser is comparatively of small size. E, is the pipe coming from the retort, *m*, a hole to allow the air to be expelled; *n*, three doors by which the iodine is raked out, filled with pieces of flag-stones and luted with clay. The end B C of the condenser should be raised a few inches higher than the end A D, to allow any water to run out (which may be sent over as steam from the retort) by the small holes *g g*; while the process is going on they are stopped with a piece of wood or lead; when iodine vapours are seen to escape by the air-hole *m*, a stopper is loosely inserted into it.

The liquid in the retort being brought to boil by either coals or peats, the fire is made very low to keep it as near the boiling point as possible, but not to have it boiling, for then steam would be sent over along with iodine, and fill the condensers with water. The lid D, fig. 13, and the arms X, figs. 11 and 12, are then put into their places and luted; finely ground manganese is now poured in by the hole E, fig. 12, in small quantities of six or eight ounces at a time, and the stopper E is immediately put into its place, and made tight by pouring a little manganese round the joint. At each addition of the manganese, quantities of iodine vapours will rise and pass over into the condensers, where it will crystallise. C, fig. 12, is a small hole provided with a leaden stopper, which is lifted up before each addition of manganese, to see

if the retort is still working; as long as iodine vapours escape freely by this hole, all the others are kept shut; but when the vapours begin to cease, the hole E is opened, and more manganese poured in. The liquid should be frequently stirred by a piece of wood through the opening E. When the violet-coloured vapours cease to rise on the addition of manganese, a little of the liquor is drawn up, and sulphuric acid added to it: this is poured into a small glass retort, and brought to boil with a spirit lamp or a few hot coals, and then a little manganese added, keeping it boiling all the time, because, towards the end of the process, the hydriodic acid is more difficult to decompose, therefore the liquid must be kept boiling; if too much manganese has been added, iodine vapours will be freely given off on the addition of sulphuric acid alone. Whether on the addition of sulphuric acid alone, or sulphuric acid and manganese, iodine vapours are given off, the same is done with the liquid in the retort. In this manner, by careful management, the whole of the iodine may be driven over and condensed in the receivers. As soon as the operation is finished the liquid should be taken out of the retort, to prevent any continued action it may have upon the iron pan. This liquid is generally run away as of no use; an impure soda ash might be made from it, but not economically in the Highlands, as even where coals abound it is not considered worth the trouble and expense. At the end of the fifth operation, the holes *g* of fig. 15 are left open for two days, or the condensers S, figs. 11 and 12, are removed and placed on their mouths for this time, (whichever of these two condensers may be used,) to allow any water from condensed steam to run out. The doors *n* of the former condenser, or the halves of the bottoms of the latter, are removed after draining for two or three days, and the iodine swept out by a wire brush into glass bottles, and firmly rammed down. These bottles are finally placed on their mouths for a week, and then corked, sealed, and packed into boxes.

Souberain's process, in which the iodine is precipitated by protosulphate of iron and copper, as diniodide of copper, which is collected and decomposed by manganese and sulphuric acid, is never made use of in this country by the iodine manufacturer, on account of its expense.

If a very fine article of iodine is wanted, it may be made by subliming the iodine obtained as above over again, from a large earthenware bottle placed in hot water, and having a lead tube inserted into its mouth, leading into either of the two forms of condensers given in the figures. The bottle used as a retort should not be more than half filled, and the water should be kept hot from a fire underneath the pan into which it is put.

Four sets of vats, (each set being four vats,) with six boiling

pans, the size of the figures given according to the scales, and twenty coolers, each as large as one of the boiling pans, will use about 600 tons of kelp per annum; the iodine retort of the size given will only require to work two days each week for this quantity, each operation requiring one day to finish it. The following men are required—

2 men at 12s. per week each, breaking kelp.
1 man at 14s. per week, filling, emptying, and firing the pans.
1 man at 12s. per week, emptying the coolers and lifting the muriate of potash.
1 man at 40s. per week, to the iodine department.

The following calculation shows the different quantities of iodine, muriate of potash, &c., given from 11½ tons of kelp, with a calculation of the profit according to the prices of 1843, although I am aware that the price of iodine is much higher now (1847) than it was then; the sum for coals should also be deducted from the expense, if the manufacture of muriate of potash is carried on by the heat evolved during the combustion of the sea-weed; also from the kelp, the profit of the person who purchases it in the Highlands, with his expense of bringing it from thence—

11½ tons of kelp at 50s., ...	L.28 15 0	
Wages for 1 week as before stated, .	4 10 0	
Coals, 10 tons at 8s., ...	4 0 0	
Manganese and sulphuric acid, . .	0 15 0	
Rent, also tear and wear, ...	1 10 0	
Weekly expense,		L.39 10 0
3½ tons muriate of potash at L.10, .	L.35 0 0	
2 tons of soda salts, at 30s., ...	3 0 0	
26 lbs. of iodine at 5s. 4d. per lb., .	6 18 8	
		44 18 8
Profit, ...		L.5 8 8

Different cargoes of kelp vary considerably in the quantities of iodine they contain, the reason of which requires observation and investigation of the kelp manufacture.

The processes I have given are the result of experience in the manufacture of iodine and the valuable salts of kelp, and any improvements I have made in the apparatus, (which are mentioned in the description of each,) I have used for similar purposes; as, for example, the method of evaporating the kelp liquid by dried sea-weed, is used in the evaporation of soda liquids by the heat given off from a reverbatory furnace, in which the crude soda is fused, the heat from it passing round a pan in the same manner as in fig. 9, Plate VIII. There is, therefore, the result of no experiments to mention, having used each improvement practically in similar processes.

CHEMICAL INVESTIGATION OF THE POTATO.

By P. F. H. Fromberg, from Amsterdam, First Assistant in the Laboratory of the Agricultural Chemistry Association of Scotland.

[Premium, Fifty Sovereigns.]

In entering upon the present subject, I need hardly draw attention to its importance at all times, but especially in present circumstances. If we consider how many millions of persons, in different countries, find in this useful esculent their principal food; in what various ways the cultivation of this plant is carried on; the peculiar poisonous character of the natural family to which it belongs; and finally the fact, that the potato plant, almost ever since it has been cultivated, has been subject to various though partial diseases—the causes of which are still but imperfectly known: then every inducement held out for the enlargement of our knowledge in regard to it, will be hailed with pleasure.

But if we turn our eyes to the more immediate and disastrous calamity, which within the last two years has befallen this plant to such an enormous extent, and in such an alarming degree, then the subject becomes one of paramount importance, and every invitation to attempt to discover the causes of the disease to which it is subject, ought to be hailed with enthusiastic delight; every serious attempt to meet this invitation should find an encouraging reception.

It would be against my proposed arrangement to give an account of the various theories that have been conceived and propounded to explain the present subject. Every one has had ample opportunity to become acquainted with these, and to form an opinion as to their several claims to probability. I have made it my object to advance no theory whatever, being convinced that nothing but well-ascertained facts can ever form a firm basis for a sound and lasting theory, and equally aware of the uncertainty that still prevails with regard to this disease.

I will therefore confine myself to giving a statement of the several facts that I have found during the present chemical investigation. Several of these facts are not at all devoid of importance, and it is only the comparative want of time, looking at the vast extent of the subject, which has prevented me from more fully investigating it. A number of investigations are still to be carried out, and these, whatever the fate of the present essay may be, will form not an uninteresting continuation of it. The partial conclusions which the facts about to be presented

have led to, will be limited as much as possible by positive evidence, whilst their enlargement can only be expected from more enlarged investigations.

For the opportunity of performing the following analyses, I have been indebted to the situation to which I am at present appointed; and I feel happy to state this publicly. I am bound to express my sincere acknowledgment to Professor Johnston, not only because I have been permitted to pursue these investigations in his laboratory, aided by his advice, and at his expense; but also, because he has allowed me the use of the analyses of three others of his assistants, Messrs Furlonge, Thomas, and Cameron, by which the number and value of my own results have been considerably enlarged.

I must also state my obligations to Mr Duke, who, having performed a number of analyses in the same laboratory, has kindly allowed me to insert them in this paper.

I shall indicate the analyses of these four gentlemen by their respective initials. Those not marked are my own results.

Mr Handyside of Lochend farm, and Mr Dale, Liberton-mains, have most liberally provided, at fixed intervals, sufficient quantities of the growing plant necessary for the investigation of the potato in successive periods. These gentlemen have thus conferred considerable obligations upon us.

Before proceeding to mention the results of these researches, I may be permitted to state, that the chief question proposed to be answered was, the composition of the several parts of the potato itself, both organic and inorganic, in various stages of growth, in sound and unsound conditions, in different varieties and from different places. After careful consideration of the facts, observed in different countries, which I have had some opportunity of learning, the condition of the soil, both chemical and physical, appeared to have little or nothing to do with the disease, as the soil seemed to have no marked influence upon it, however different the structure and composition of the former might have been in various countries. It is for this reason that attention has been directed almost entirely to the plant itself, and that only one or two analyses of soils are given, which appear satisfactorily to prove that they had little or no influence upon the present disease.

The methods of analysis which I have adopted, are the following:—

1°. *For the Organic Part.*

The potato was first carefully peeled. A quantity of between five and six hundred grains was weighed and grated over a piece of fine muslin, tied over a beaker glass. The pulp was washed

upon the muslin with distilled water, until the latter came through quite clear and tasteless, and a drop of it left no residue after evaporating upon a piece of glass. The fibre was carefully collected from the muslin, and dried at two hundred and twelve degrees, until it ceased to lose in weight.

(*a.*) *Determination of the Starch.*

The liquid that came through the muslin, after being well covered and mixed with a few drops of ammonia, was allowed to subside for twelve hours. It was now drawn off clear, the starch remaining at the bottom of the vessel repeatedly washed with distilled water, and carefully separated from the finer particles of fibre which usually passed through the muslin. This portion of fibre, was added to the former, or, when this separation could not be satisfactorily performed, the greater portion of starch was separated, and the remaining mixture perfectly dried, weighed, digested with dilute sulphuric acid, to dissolve and remove the starch, further frequently washed to separate all the acid, and finally dried till the weight was constant. The difference between the two weighings, before and after the treatment with dilute sulphuric acid, was calculated as starch. When quite pure, the starch was collected either upon a weighed filter or in a weighed cup, first dried in the air, then at a little higher temperature, and at last at two hundred and twelve degrees, till the weight was constant.

(*b.*) *Determination of the Albumen.*

The liquid from which the starch had been separated, was divided into two equal parts. The one half was boiled for a few minutes in an imperfectly closed flask. The albumen coagulated was allowed to subside, the clear liquid poured off, and the residue repeatedly washed, collected on a weighed filter, washed, and further dried as above.

In some cases, I determined it in the other half, from which I had first precipitated and removed the so-called casein, by adding carbonate of ammonia to the liquid containing free acetic acid, until it was slightly alkaline, and subsequently heating it. The precipitate was treated as before.

(*c.*) *Determination of the* (*so called*) *Casein.*

The second half, which had not been boiled, was mixed with an excess of acetic acid. The precipitate was allowed to subside, then collected upon a weighed filter, washed with distilled water, &c.

The former half, from which the albumen had been separated by boiling, was treated in the same manner.

The reason why this division was adopted, was to ascertain whether the quantities of casein and albumen, obtained from each half, would always agree with one another, or whether the heating of the liquid could have any effect upon the properties of either of these substances, and thus cause a difference in the respective quantities. The results which I am to communicate in the course of this essay, will show that the latter was usually the case.

(*d.*) *Determination of the Dextrin.*

When carbonate of ammonia had been used to precipitate the albumen from the one half, the other half alone was used for the determination of the dextrin; but otherwise, the two halfs were added together. The liquor was evaporated on a water bath to a very small bulk, mixed with a large quantity of alcohol, the precipitate collected on a weighed filter, washed with alcohol, dried, &c.

(*e.*) *Determination of the Saccharine Matter.*

The liquid was distilled to save the alcohol; the watery remainder evaporated in a weighed cup on a water-bath, and further kept at a temperature of two hundred and twelve degrees, till the weight was constant.

(*f.*) *Determination of the Fibre.*

The fibre, after being perfectly dried and weighed, was powdered and introduced into a tubulated retort, connected with a receiver, which was fitted on so as to leave an outlet for the air. The retort was placed in a water-bath, and filled for about three-fourth parts with alcohol. It was now boiled half an hour, the fibre allowed to subside, and the clear alcoholic liquid poured off. This operation was repeated three or four times. The fibre was then taken out of the retort, again dried, and weighed.

(*g.*) *Determination of the Glutin.*

The alcoholic solution was gently distilled off, the watery residue collected into a weighed cup, evaporated on a water-bath, and subsequently dried at two hundred and twelve degrees, until it lost no longer in weight. This cup was now placed in a wide-mouth vessel, which could be closed, and ether poured upon it, with which it was digested for about half an hour, the vessel being placed in warm water. This was repeated two or three

times, the cup was then taken out, dried at two hundred and twelve degrees, and weighed. What it contained was considered as glutin, and frequently tested by means of nitric acid and ammonia, to ascertain whether it showed the characteristic colour of the xantho-proteate of ammonia.

(*h.*) *Determination of the Fat.*

The ether was cautiously distilled in a retort placed in warm water until it was reduced to a very small bulk. The remainder was then removed from the retort, collected into a small weighed cup, and dried till the weight was constant. It was generally found that the quantity of fat, thus obtained directly, agreed with the difference between the two weights of the gutin, before and after it had been treated with ether.

2°. *For the Inorganic Part.*

The substances, after being previously cleaned from adhering sand, were always burned in platinum crucibles, which were placed over the lamp in an inclined position, and half covered with the lid. The flame was so regulated that the crucible never became red-hot, for fear of fusing the ash. When the latter had become perfectly white and free from charcoal, a quantity of it was weighed for analysis. This was digested in a mixture of hydrochloric with a little nitric acid, and if I had abundance of ash, the chlorine determined in another weighed quantity, which was for that purpose boiled in water, to extract all the alkaline salts. In case I had not so much ash at my disposal, the same quantity from which I separated the chlorine was used through the whole analysis. The part insoluble in water was then treated with the above-named acids, and the acid and watery solutions mixed together, the excess of silver being then at the same time thrown down.

The filtered liquid was evaporated to dryness, and then re-dissolved in acid, to separate the soluble silica. I then precipitated the phosphates by adding ammonia in some excess. These were re-dissolved in hydrochloric acid, and re-precipitated by ammonia, and a small excess of acetic acid added. What remained insoluble in the latter acid was phosphate of iron, of which the composition was several times ascertained. The solution was mixed with oxalic acid, to separate the lime; the phosphate of magnesia was subsequently thrown down by adding ammonia in excess; and at last the remaining phosphoric acid, that had been combined with the lime, was determined by means of sulphate of magnesia and ammonia.

In the liquid from which the phosphates had been removed, the lime was thrown down by oxalic acid, the solution rendered acid with nitric acid, chloride of barium added to determine the sulphuric acid, the excess of baryta removed by ammonia and a current of carbonic acid, and the remaining solution evaporated to dryness, strongly heated so as to expel the whole of the ammoniacal salts, the residue weighed, mixed with binoxide of mercury and a little water, again heated to drive off the whole of the mercury salt, weighed, and quickly washed out with boiling water. The caustic magnesia was separated by filtration, and the carbonate of baryta, with which it was still mixed, separated by sulphuric acid. The solution was now again evaporated to dryness, and the residue weighed, re-dissolved in a small quantity of water, the potash determined by an alcoholic solution of bichloride of platinum, and, finally, the soda calculated in the usual way.

I may now at once proceed to the subject itself, which I have divided into two chief parts,—I. Of the Composition of the Tuber; and, II. Of the Composition of the Tops.

Part I.—Of the Composition of the Tuber.

I.—Composition of the Organic Part of the Tuber.

Section 1.— *Of the quantity of Water in the Tuber.*

(a.) Water in the Young Potato.

I have only to offer four results of this kind, but which prove sufficiently that the young potato contains less solid matter than when full grown, a fact which is in accordance with what we know of the growth of plants in general; succulent fruits being not excepted from this rule, as has been shown by Bérard.

	1. South American.	2. Young kidneys, (ash leaved.)	3. Bufts from a farm in the Lothians.	4. Do. a week later.
Water, per cent,	78·58	78·64	82 88	82·01

The two former kinds were, to all appearance, completely sound; the latter became subsequently diseased. The first were small in size, but very regularly formed. The history of the second is as follows:—" The crop of 1845 was raised about the middle of October, and spread upon the surface, to green with the sun for eight days. They were then pitted into a small pit. At this time there was little appearance of disease; but, on

examination, by the 20th of November they were in a very bad state. They were then taken out of the pit, and carried into a back shed. The best of them were cut and laid past among dry earth and lime rubbish, with a view to keeping them dry. Still there were a good many of them lost. Those that escaped the disease appear to be doing very well, in proof of which the present dish will show. They were planted on the 14th of February 1846, on a slight hotbed, and were protected by glass during cold or very stormy weather till the middle of April; since, they have been exposed to the open air." This letter was dated the 26th of May 1846, and I received the new potatoes about the same time. They were remarkably fine-looking, though not of a large size. I kept them for a considerable length of time, but they remained perfectly sound.

The two of the latter kind were grown upon a light sandy loam on a gravelly subsoil, and manured with farm-yard dung.

As the first came from America, they may have easily lost a portion of their moisture during the voyage; but the difference of four per cent between the second and the two latter, which became diseased, deserves attention.

(b.) Water in the Ripe Potato.

1.	2.	3.	4.	5.
From Lanark, Red Variety.	From E. Lothian, White Variety.	Small Americans, from Forfarshire.	Sound Cups, from Argyleshire.	Sound Cups, from Mid-Lothian.
76·07	80 00	72·58	74·83	73·78
6.	7.	8.	9.	10.
Canadians, from Forfarshire	Sound Potato, from the Orkneys	Buffs, from Forfarshire.	Red Potato, from Ayrshire.	Kidney, from Northumberland.
66 23	65 09	64·94	77·47	73·16 D.

I may remark, with regard to those of which the per centage of water is below 70, that they had been in the laboratory for some time before the water was determined. The one containing 80 per cent was certainly a sound potato, but from a field of which the crop was partly diseased, and by continued keeping they became nearly all diseased, although kept in a dry and airy place

(c.) Water in different parts of the same Potato.

The fact, that shoots are emitted more rapidly and abundantly from the so-called rose end than from the heel end of a potato,

leads to the supposition that some organic difference may possibly exist between the two ends. Although the amount of moisture might at the first sight seem to be very little connected with such difference, yet a little consideration will soon show the reverse. Not only are the solid parts of a plant softened by moisture—and, being rendered more tender, thus offer less mechanical resistance against the protruding shoots—but this moisture serves at the same time as a solvent to those parts of a plant* which, after having been transformed by a kind of katalytical action, are intended to produce and to nourish new parts in every direction. The more, therefore, these important constituents are diffused, the more vigorous will be the growth of the plant; and this diffusion itself will be rendered so much the more easy and complete, in proportion as, *within certain limits*, the quantity of water, in which a given quantity of these constituents is dissolved, increases.

Upon this principle, we thought it necessary to determine the proportion of water present in different parts of a potato, and more particularly in the two extremities, the heel and rose end, we obtained the following results:—

1.	Buffs from a farm in the Lothians.	The same in another period	Do. in another period.	Belfast Rounds.	Cups from Argyleshire.	Seedling Potato.	
Rose end,	82·88	81·14	82·60	C. 70·73	74·31	D. 82·25	
Heel end,	80·15	76·68	74·80	69·89	72·06	77·06	
Centre,	...	...	85·13	80·03	80.66	84·37	
7.	Early potato from Renfrewshire.	Perth Reds.	Cups.	Kidneys.	Grey's Kidneys.	Ash-leaved Kidneys.	Small Americans.
Rose end,	D. 80·66	D. 68·34	71·97	D. 80·07	D. 76·56	81·98	76·19
Heel end,	81·49	74·04	74·64	65·33	71·78	76·94	71·02
Centre,	77·86	79·17	79·91	73·77	75·30	...	...
14.	Sound Cups from Argyleshire.	Diseased Cups from the same field.	Sound Cups from Mid-Lothian.	Diseased Cups from the same field.	White Potato from East Lothian, kept for 2 months	The same, 1 month later.	The same, 2 months later.
Rose end,	74·93	71·84	74·36	79·60	69·78	68 70	68·45
Heel end,	74·57	66·97	72·17	77·83	69·36	68·36	67·92
21.	Buffs from Mid-Lothian, after sprouting.	Do with with sprouts of the double length.	White potato from Dumbartonshire.	South Americans.	Canadians.	Buffs from Forfarshire.	Sound from the Orkneys.
Rose end,	75·42	88 89	71·07	78·74	64·41	66·50	61·92
Heel end,	76·11	88·07	66·60	78·41	63·02	63·38	61·21

* Namely, the protein compounds and dextrin.

It was considered necessary to make this large number of experiments, in order to prove—what seems to be an almost general fact—

1°. That the part from which the shoots are the most quickly and abundantly produced, contains more moisture than the opposite end.

2°. That it appears also to be a fact, that the central part of a potato contains a greater quantity of water than any other.

3°. That even when potatoes become drier by keeping, the same difference between the heel and rose end, although in a smaller degree, seems to remain.

4°. That, in general, this difference is smaller in perfectly sound potatoes than in those that are diseased, or only remain sound for a certain time; for the buffs, examined at successive periods, the cups from Mid-Lothian, those from Dumbartonshire, &c., either were or soon became diseased; whilst the South Americans, the sound cups from Argyleshire, Canadians, and those from the Orkneys, were, and remained, unaffected.

One cup variety, the Perth reds, and the early potatoes from Renfrewshire, appear to have contained more water in the heel end than in the other extremity. With regard to the Perth reds, I must remark that they were of an unusually large size, and a very irregular shape. The early potatoes looked very watery. The buffs, mentioned under Nos. 21 and 22, had been stored for some time in a pit, or rather in a heap of earth above the ground. The shoots they had emitted were particularly strong, and those of the latter, which were about twelve inches long, had even produced a few leaves.

(d.) Water in different varieties of Potatoes.

It can hardly be expected that experiments made on this subject would lead to any general conclusion. The potato, like every other plant, is so much liable to be affected by differences in climate, and other circumstances, that small differences of moisture in different varieties cannot remain perceptible, and will often become reversed. A potato, usually dry and mealy, may become watery when grown in a different locality, and *vice versa*. The mealiness of a potato appears to be owing to the presence of a substance in the cells incapable of being washed out by the water, and the cells being filled with it, they can hold a smaller quantity of water than otherwise. When the mealy part, or starch, has been more or less replaced by some other product, readily soluble in water, such as gum, the solid contents of the cells may be partly washed out, and its place taken up by the water.

With a view, however, of ascertaining whether this point bore any relation to the different degrees in which various varieties have

been affected, a few determinations were made for this special purpose, with the following results. I have mentioned most of these already at page 643, but I will here give the determinations in full:—

	From Lanark. Red Variety.	From East-Lothian. White Variety.	Small Americans from Forfarshire.	Sound Cups from Argyleshire.	Sound Cups from Mid-Lothian.
1st determination,	68·58	79·64	72·92	73·31	74·46
2d do.,	71·14	80·44	74·54	73 64	72·29
3d do.,	76·07	79·93	72·58	74·83	73·78
	Canadians from Forfarshire.	**Sound Potato from the Orkneys.**	**Buffs from Forfarshire.**	**Red Potato from Ayrshire**	**South Americans.**
1st determination,	66·20	61·10	60·71	77·35	76·38
2d do.,	66·27	62·17	63·38	78·13	82·00
3d do.,	...	65·09	64·94	76·83	78·58
	Buffs from Mid-Lothian.	**Cups, (place not ascertained.)**	**Kidneys, do.**	**Grey's Kidneys.**	**Buffs from Fifeshire.**
1st determination,	77·03	D. 75·51	73 06	D. 74·55	79·12
2d do.,	76·64	...	...	...	...
3d do.,	74·83	...	...	...	...

With regard to these results I must remark, that the buffs from Mid-Lothian gave 74·83 per cent of water at one period; but that the week immediately before they contained 82 per cent, and the week immediately after, about 81 per cent of water. It is further evident, from these instances, that different varieties of potatoes, and even different specimens of the same variety, actually contain different proportions of water, which may partly depend upon the degree of heat and humidity in the air prevailing in different places; but which cannot be thus accounted for when the same varieties had been grown in different places, or the reverse. The various ways of propagation, especially from seed, which must no doubt be considered as the chief cause of the existence of these varieties, has possibly been productive of differences in the size of the cells, the nature of the cellular membranes, the proportion between the number of cells and vessels, &c., and thus a different capability of holding moisture may have originated. It is in this light that I am inclined to look upon the connexion of these differences in the proportion of water with the greater or less liability to disease, even in specimens of the same variety, rather than to ascribe this liability to differences in the structure of the soil, &c.

(e.) *Water in Diseased Potatoes.*

It is with a kind of hesitation that I have approached this

point, because it has been confidently stated that diseased potatoes contain more water than those that are sound. It has occurred to me that we must distinguish here between the various stages of the disease. Excess of moisture in the cellular tissue of a potato, may have been a predisposing or facilitating cause to the production of the disease; and this, having once set in, may thus have altered the structure of the potato, so as to render it liable to a more rapid exsiccation. The gradual destruction of the epidermis of a diseased potato, which appears to be in *a sound specimen* mainly serviceable to prevent this exsiccation, renders it unlikely that a diseased tuber could for any length of time retain its natural proportion of water; and this indeed seems to be borne out by the following results:—

	Sound.	Diseased.	Do., kept for one month.
White variety from East Lothian,	80·00	71·77	69·57
Cups, ...	74·83	70 41	...
Cups, ...	73·78	77·95	...
Buffs, ...	76·83	83·21	...
Red variety, from Ayrshire, .	78·13	77·70	...

In the last instance, (red variety from Ayrshire,) the potatoes were analysed shortly after their arrival, and the disease had only commenced a little before. The second kind of cups seems to be an exception; but when I mention that these were left in the ground almost until the moment they were examined, whilst the first had been kept for some time—both sound and diseased for the same period—it will be found to be rather a confirmation than an exception. The epidermis having once ceased to perform its natural function, the potato will be apt equally to imbibe or to lose water, according to the state of the medium in which it is placed. The same applies to the buff variety here mentioned.

I think, therefore, that the differences in the proportions of water in sound and diseased potatoes, are mainly attributable to external circumstances, which the latter are less able to resist than the former, on account of the state of their protecting envelope.

(*f.*) *General average proportion of Water in Sound and Diseased Potatoes.*

We are not very far from the truth in assuming the following proportions:—

	Average for Sound Potatoes.	Average for Diseased Potatoes.
Per centage of water, .	75·52	76·65

The former number is the mean of 27, and the latter of 24 different determinations; but it is remarkable, that whilst the maximum and minimum in the former are 82· and 68·58, they

are in the latter 85·04 and 66·37, making a difference of more than 5 per cent between the limits in the two cases, or, generally speaking, the diseased contained a smaller, though less uniform, proportion of water than the sound potatoes.*

A number of years ago, the proportion of water in several varieties of potatoes had been determined by Einhoff, Körte, Lampadius, Henry, and Payen, and the general results at which they respectively arrived were:—

Einhoff, . . .	76·3 per cent.
Körte,	75·1
Lampadius,	74·5
Henry,	73·1
Payen,	74·3
Mean, .	74·7

This average result is about one per cent below that given above. There would seem from this to be some reason to assume that the potatoes were in the last two years impregnated with a greater quantity of water, and that this water was less equally divided among the different parts of the potato than was generally found before. If we take the mean of the following numbers, 80·94, 78·86, 78·89, 80·78, 80·00, viz 79·89, (being the proportions of water in potatoes that either exhibited the very first symptoms of disease, and were at the same time left in the soil, or were taken from fields with a partly diseased crop,) then it would appear that there existed a greater quantity of water in the tuber than used to be considered as the natural proportion. But even if this might be correct, I would not venture to make it the basis of a theory.

Section 2.—*Proportion of Starch and Fibre in the Potato.*

(a.) In the Young Potato.

	1. Ash-leaved Kidneys.	2. Buffs from Mid-Lothian.	3. Do, a fort-night later.	4. Early potato, Renfrewshire.
Starch, .	9·52	5·53	7·51	D. 9·14
Fibre, . .	4·23	4·53	4·69	4·87

I may remark with regard to No. 3, that the week following, (15th August,) the proportion of starch amounted to 14·89 per cent, whereas on the 22d August it fell to 10·5, and on the 29th it was about 11 per cent, at both of which latter periods the quantity of water had risen to 80·94 and 78·86 per cent. In the meanwhile, the disease had distinctly manifested itself, the leaves being gradually blackened and destroyed.

We further perceive from these results, that the proportion of starch is gradually increasing in the process of growth, it being no doubt an effect of the gradual transformation of dextrin, the

* See Proceedings of the Agricultural Chemistry Association. *Part IV.*

soluble material of which the insoluble globules of starch, and the primary cellular membrane, are successively built up.

The fibre includes the glutin and coagulated albumen, and a small quantity of fatty matter besides.

I would add here also, the determination of starch and fibre obtained from the last year's cuttings of the buffs from the same field, viz.—

	30th May 1846.	13th June 1846.
Starch, . .	5·50	0·05
Fibre, . .	2·35	1·51

The rapid diminution and final disappearance of the starch from these cuttings is remarkable, and the less rapid decrease of the fibre is in accordance with its more solid structure. It is possible that the production of the new plant was a cause of this diminution; but it would appear that the medium in which the tuber was placed, viz. the soil, was not without influence in this case. This at least seems to follow from a comparative experiment that I made with a white variety of potatoes from Mid-Lothian, which I allowed to sprout in a wooden box, moistening them daily with distilled water. On analysis, I obtained the following results:—

	7th February.	7th May.	7th July.
Starch, . . .	14·32	16·73	21·00
Fibre, . . .	4·96	5·69	9.67

This increase of starch and fibre in the progress of vegetation is not real, but owing to the decrease in the proportion of water, as will be seen, by representing the starch and fibre as they would have existed in the dry potato; for as there was of water at the

	First Period.	Second Period.	Third Period.
	76·72	70 84	57·91
We obtain in the dry state of			
Starch, ...	61·51	57·37	49·90
Fibre, ...	21·30	19·51	22·94

The decrease, therefore, of the starch is partly caused by the sprouting of the tubers, (which the latter had done abundantly,) but is materially accelerated when their vegetative powers are brought into action within the soil, being then probably assisted by the moisture, and especially by the decaying organic matter which is always present in the soil. The latter communicates its own state of decomposition to any organised body that is planted in it;—only with this difference, that there the decomposition of the organic matter takes a different direction from what it did in the soil itself, being now subjected to the peculiar endosmotical ac-

tion—if I may so call it—of the cellular membranes, and thus giving rise to different products.

In the inverse process, that is, of *increase* in the quantity of starch, we must look for a different cause. In the first case, a new plant was produced at the expense partly of the starch and fibre of the old set; but when this new plant is sufficiently advanced in growth to produce new tubers, the latter owe their increase in starch to the dextrin, which is continually produced mainly by the action of the leaves and other green parts.

(*b*.) *In the Ripe Potato.*

The proportions of starch and fibre in the ripe potato are subject to several variations, as will hereafter appear. I may here mention, however, that from four perfectly ripe and healthy specimens, the following results were obtained :—

	1. Red Variety from Lanark.	2. Sound Cups from Argyleshire.	3. Sound Buffs from Mid-Lothian.	4. White Variety from Mid-Lothian.
Starch,	14·08	15·14	14·89	14·32
Fibre,	4 58	4·53	4·45	4·96

These proportions nearly agree with what is generally considered as the average one, and, when more or less was found, this was often caused by a variation in the degree of moisture, as I will show presently.

(*c*.) *In different parts of the same Potato.*

The results obtained under this head, though small in number, are however very interesting, viz.—

	C. Belfast Rounds.			Red Potato from Argyleshire.			D. Grey's Kidneys.		
	Rose end.	Centre.	Heel end.	Rose end.	Centre.	Heel end.	Rose end.	Centre.	Heel end.
Starch,	19·15	14·40	18·70	10·42	13·73	20·93	14·84	13.87	17 48
Fibre,	7·13	3·67	3·33	5·67	3.29	4·11	2 84	2·94	3·40

These three varieties of potatoes seem to agree with regard to the proportion of starch in the centre, where it appears to be smallest. In the two first, the amount of fibre seems greatest in the rose end, and in the two last the quantity of starch is greatest in the heel end; but all further similarity ceases. In the first, the centre contains a little more fibre than the heel end; in the second, the opposite relation exists, and in the third, the rose-end and centre are equal.

But here, again, the relative proportions of these solid constituents have been altered by the different quantities of water, as will appear from the following calculations:—

	Belfast Rounds.			Red Potato from Argyleshire.			Grei's Kidneys.		
	Rose end.	Centre.	Heel end.	Rose end.	Centre	Heel end.	Rose end.	Centre.	Heel end.
Water.	70·73	80·03	69 89	74·31	80·66	72·06	76·56	75·30	71·78
Calculated dry.									
Starch,	65·46	71·98	62·11	63·90	71·00	74·91	67·62	56·15	61·94
Fibre.	24·36	18·34	11·06	22·06	17·01	14·71	12·12	11·90	12·05

We see therefore, in the one case, that the largest amount of starch is present in the centre; that, in the other, it approaches to the heel end, in which it is still the greatest. In the third instance, the rose end contains more starch than the heel end, whilst formerly the inverse ratio existed; in the centre, the quantity remains the smallest.

The proportion of fibre in the centre is a medium between that in the two ends, the difference being, however, exceedingly small; whereas formerly that in the heel end was the largest, and in the rose end the smallest. In the two first instances, the heel end contains the smallest, and the rose end the largest quantity of fibre, the centre being a medium between the two.

We thus perceive that the cells in the centre being more replete with moisture than those in both ends, the starch globules are scattered over a large surface, which, after contracting by the loss of that moisture, alike with the remainder of the potato, contains (in the two first instances) an amount of starch which may be even greater than that in any of the other parts.

The peculiar form of the kidneys may have something to do with its deviation from the two round varieties here mentioned, although the exact nature of this influence of form cannot be explained. It would appear from these results, that it must not be assumed as a fact, that the heel end should always be richest in starch, and therefore best fitted for producing good potatoes for food. It may perhaps be, that the real cause of the difference between the two extremities is owing to a diversity in structure, the rose end being more filled with vessels than the heel end; and as, so far as we know, vessels contain nothing else than acid or water, or both, the cells, on the other hand, being the depositories of solid products of *any* kind, we will understand how that part, in which the cells prevail, can be the driest, without necessarily being the richest in starch.

(d.) *In different varieties of Potatoes.*

Under this head we examined a considerable number of potatoes, with the following results:—

1.	Red Potato from Lanark.	White Potato from Argyleshire.	White Potato from Mid-Lothian.	Do. 3 months later.	Do. 5 months later.
Starch	14·08	18·07	12·24	16·73	21·00
Fibre	4·38	10·60	4·40	5·69	9·67
6.	Small Americans.	South Americans.	Canadians.	Cups from Argyleshire	Cups from Mid-Lothian.
Starch	17·80	8·14	20·92	15·14	23·82
Fibre	4·65	4·83	6·41	4·53	3·46
11.	Sound Potato from the Orkneys.	Buffs from Mid-Lothian.	Do. 1 week later.	Do. 2 weeks later.	Cups from Mid-Lothian.
Starch	17·42	14·89	10·40	11·07	18·94
Fibre	8·41	4·45	4·33	4·68	1·75
16.	Buffs from Forfarshire.	Ash-leaved Kidneys.	D. Perth Reds	D. Kidneys from Northumberland.	
Starch	20·71	14·93	16·53	18·23	
Fibre	7·38	1·49	3·63	4·48	

As several of these specimens had been kept for some time previous to analysis, we shall be better able to judge of their several proportions of starch and fibre, by again calculating them in the dry state:—

1.	Red Potato from Lanark.	White Potato from Argyleshire.	White Potato from Mid-Lothian.	Do. 3 months later.	Do. 5 months later.
Starch	58·84	60·82	61·20	57·37	49·90
Fibre	18·30	32·12	22·00	19·51	22·94
6.	Small Americans.	South Americans.	Canadians.	Cups from Argyleshire.	Cups from Mid-Lothian.
Starch	65·00	38·04	61.92	60·15	75·14
Fibre	17·00	22·57	19.00	18·00	10·91
11.	From the Orkneys.	Buffs from Mid-Lothian	Do. 1 week later.	Do 2 weeks later.	Cups from Mid-Lothian.
Starch	49·91	59·16	54 56	52·36	77·30
Fibre	24·10	17·70	22·72	22·13	7·14
16.	Buffs from Forfarshire.	Ash-leaved Kidneys.	Perth Reds.	Kidneys from Northumberland.	
Starch......	59·07	76·41	63·24	67·52	
Fibre	21·05	7·62	13·90	15·60	

Several interesting remarks are to be made upon these results, both those represented in the naturally wet, and those calculated in the dried potatoes.

In the first place, we perceive from the former table, that the proportion of fibre, including glutin and coagulated albumen, is very frequently between 4 and 5 per cent; and from the comparison of the two tables, it is evident that, with one exception only, (No. 2,) the numbers above 5 per cent owe their origin to a decrease in the proportion of water.

With regard to this exception, I must mention that these potatoes were growing on new land, being a portion of a crop of which it was thought, previous to lifting, that at least the half would remain sound, but which were subsequently found to have been nearly all affected. I could perceive no trace of disease in this specimen, which was a remarkably fine one. It was kept for some time in a closed wooden box, but no symptoms of disease manifested themselves. It sprouted very early, which is not a sign of a perfectly healthy state; the sprouts were all covered with a white fungus, and could very easily be broken off. We see from the result, that the proportion of starch does not much deviate from the majority of the other results, but that the fibre differs from most of the others by more than one-third.

These tables show, in the second place, that the limits between the proportions of starch in potatoes of a healthy condition, are in general not very different; for even in the dry state, with three exceptions, they vary only from 58 to 67 per cent—that is, in the natural state from 14·2 to 16·4 per cent.

A third point, to which I would draw attention, is the change produced in the potato from Orkney, after sprouting, when comparing it with the generality of the other results. As this potato had been in exactly the same conditions as the white variety of which I have just treated, (No. 2,) but differed from it by being perfectly sound—the shoots being also very firmly attached, and not covered with any fungus-like substances—it is interesting to compare the proportions of fibre and starch in the two sprouted specimens. We thus find, that in the specimens from Orkney the proportion of fibre has scarcely increased, whilst that of the starch seems to have been considerably diminished. We will remember that in the other specimens the proportions of starch had not been much altered, but that of fibre increased. We would, therefore, naturally be inclined to ask—Have the weak and moulded shoots in the latter specimen been chiefly produced from the saccharine and nitrogenous substances; and has the proportion of fibre, by a retrograde process, been increased? Whilst in the Orkney specimens part of the starch has been appropriated to the production of new shoots, (as was the case in the

white variety from Mid-Lothian, of which I treated before, p. 649,) and was the fibre left unaffected? Further—Might the stronger and more healthy appearance of the shoots from the latter specimen be explained on these grounds, and the increase of fibre in the former be connected with the nature of the disease, which is known to be seated chiefly in the cellular tissue?

I merely put these questions here, as they seem naturally to follow from these results, but must delay to answer them until further investigations will have thrown more light upon the subject.

It is remarkable, in the fourth place, that the two specimens of buffs, which were grown in two different counties, agree so nearly in their proportions of starch. In the one, examined at successive periods of growth, the starch had reached the maximum here given on the 15th of August of this year, which was too early to consider it as full grown, and yet the leaves withered the subsequent week, and the symptoms of disease extended rapidly. The proportion of fibre, on the contrary, was then actually less than in the two following weeks; and we perceive, in that respect, something analogous with what took place in the white variety above referred to. The decrease of starch in this variety of buffs, which remained in the soil, may be accounted for on similar principles as those on which I tried to explain the same phenomenon in the old sets of the same plant. At all events, here the true proportion of starch are not much affected by the different quantities of water in the two last weeks, for the ratio, although modified, becomes more regularly a diminishing one.

The enormous quantities of starch in the cups and ash-leaved kidneys are deserving of attention; and when we compare these with the low figure in the South Americans, we seem to have met here two characteristic instances of potato—one eminently fit for food, and one equally fit for seed. The fibre in the two former is also very small in quantity, and this may have partly arisen from the large production of starch.

(e.) *In Diseased Potatoes.*

We might expect that differences will exist here, according to the stage to which the disease has advanced. It appears to me that no positive conclusion can be drawn as to the relation between the condition of the ripe potato, and the proportion of starch and fibre which it contains. I therefore give the following results merely as instances, showing how much the proportion of these constituents may be affected by the degree to which the disease has advanced:—

	1. Red Potato from Ayrshire, diseased.	2. Do. more advanced.	3. White Potato from Mid-Lothian, diseased part.	4. Diseased Cups from Argyleshire.	5. Do. from Mid-Lothian.	6. Diseased Buff from Mid-Lothian.	7. Do. a week later.
Starch...	11·01	6·08	14·59	18·42	14·27	10·40	11·07
Fibre....	2·60	5·49	4·36	5·66	2·93	4·33	4·68

Taking into account the different proportions of water in these several varieties, and calculating the per centage of starch and fibre in the dry state, we obtain the following results:—

	1.	2.	3.	4.	5.	6.	7.
Starch,	57·28	28·33	51·70	62·23	64·72	54·56	52·36
Fibre,	13·53	26·00	15·44	19·12	13·29	22·72	22·13

We here perceive, again, how much the true relation of these solid constituents is influenced by the variations in the proportions of water. If we, therefore, now direct our attention to the latter table, we shall observe—

1st, That the part of a potato which is in an advanced stage of disease, loses starch, and sometimes gains fibre, as follows from Nos. 2, 4, 6, and 7.

2d, That, however, the fibre may also diminish, as is shown by Nos. 1, 3, and 5; in which cases the decrease of the fibre would seem to lead to the belief, that the increase of this constituent in a more advanced stage is partly attributable to the transformation of the starch; for in No. 2 we find, that the increase of fibre makes up to some extent for the loss of starch, when compared to No. 1.

(*f.*) *General average proportion of Starch and Fibre.*

This may be represented by the following numbers, as derived from the results given above:—

	In the natural state.		In the dry state.
Starch............	15·72	...	64·20
Fibre.............	3·26	...	13·31

The fibre includes the glutin, coagulated albumen, and a portion of the fatty matter. I do not think it necessary to state the mean proportion of the same constituents in diseased potatoes, for the reasons given above.

SECTION 3.—*Proportions of Dextrin and Impure* Saccharine Matter.*

(a.) In the Young Potato.

	1. South American.	2. Ash-leaved Kidneys.	3. Early Potatoes.	4. Buffs from Mid-Lothian.	5 Do. 2 weeks later.
Dextrin	0·30	0·18	D. 0·27	0·85	2·88
Saccharine matter	5·12	4·51	2·26	3·97	
The same calculated dry—					
Dextrin	1·40	0 84	1·54	4·96	16·00
Saccharine matter	23 93	21·11	12·92	23·19	

If we look at the second series of numbers, we see a striking similarity in the proportions of saccharine matter in Nos. 1 and 4. It is further remarkable how large is the proportion of dextrin in No. 4, which afterwards became diseased whilst the plant was still growing. The decrease of dextrin and saccharine matter in the course of two weeks is striking. The quantity present at that date, approaches to that in No. 3.

(b.) In Ripe Potatoes.

	1. Red Potato from Lanark.	2. White Potato from Mid-Lothian.	3. Buffs from Mid-Lothian.	4. Cups from Mid-Lothian.	5. Cups from Argyleshire.
Dextrin, . .	0·71	0 33	0·31	0·94	2·58
Sacch. matter,	3·11	2·63	3·15	2·32	
Calculated dry—					
Dextrin, . .	2·98	1·42	1·23	2·97	10 25
Sacch. matter,	13·00	11·30	12·52	7·30	

In the buffs, the same as Nos. 4 and 5 in the former table, only one week older than No. 5, we see the saccharine matter, within three weeks, reduced to one-half, and the dextrin to one-fourth. A similar amount of saccharine matter appears to exist in the other varieties.

* What is called here *impure saccharine matter* contains, among other substances, some organic acids, which I in some cases found to be citric acid.

(c.) *In different parts of the same Potato.*

	C. Belfast Rounds.			C. Red Potato from Argyleshire.			D. Grey's Kidneys.		
	Rose end.	Centre.	Heel end.	Rose end.	Centre.	Heel end.	Rose end.	Centre.	Heel end.
Dextrin, . .	0·18	0·07	0·48	} 2·30	1·10	1·86 {	0·11	0·14	} 2·76
Sacch. matter,	1·70	1·70	3·27				2·70	1·78	
Calculated dry—									
Dextrin, . .	0·62	0·35	1·60	} 8·95	5·70	6·66 {	0·47	0·57	} 9·78
Sacch. matter,	5·80	8·50	10·86				11·52	7·21	

We here observe a still greater diminution of both dextrin and saccharine matter than was perceptible in the former table, with the exception of the rose end in the last variety; but further, there seems to be no regular diffusion throughout the three chief parts of the potato.

(d.) *In different varieties of Potatoes.*

	1.	2.	3.	4.	5.
	Red Potato from Lanark.	White Potato from Mid-Lothian.	Do. 3 months later.	Do. 5 months later.	White Potato from Dumbartonshire.
Dextrin, . .	0·71	0·38	} 4·11	1·09	0·14
Sacch. matter,	3·11	2·32		7·37	3·14
	6.	**7.**	**8.**	**9.**	**10.**
	Small Americans.	From Orkney.	Cups from Argyleshire.	Cups from Mid-Lothian.	Canadians.
Dextrin, . .	0·13	0·91	} 2·58	0.94	0·95
Sacch. matter,	3·24	5·01		2·32	2·60
	11.	**12.**	**13.**	**14.**	**15.**
	Buffs from Forfarshire.	Buffs from Mid-Lothian.	Do. 1 week later.	Do. 2 weeks later.	Ash-leaved Kidney.
Dextrin, . .	1·44	0·31	0·53	0·42	trace.
Sacch. matter,	3·44	3·15	2·32	2·26	1·96
	16.	**17.**	**18.**	**19.**	
	Perth Reds.	Cups.	Kidneys from Northumberland.	Seedlings.	
Dextrin, . .	D. 0·60	0·12	} D. 2·99	} D. 0·39	
Sacch. matter,	3·73	2·58			

(*d.*) *In different varieties of Potatoes—Calculated dry.*

	1.	2.	3.	4.	5.
	Red Potato from Lanark.	White Potato from Mid-Lothian.	Do. 3 months later.	Do. 5 months later.	White Potato from Dumbartonshire.
Dextrin, . .	2·78	1·90	} 14·10	2·60	0·42
Sacch. matter,	13·00	11·60		17·50	9·64
	6.	**7.**	**8.**	**9.**	**10.**
	Small Americans.	From Orkney.	Cups from Argyleshire.	Cups from Mid-Lothian.	Canadians.
Dextrin, . .	0·47	2·61	} 10·25	2·97	2·81
Sacch. matter,	9·81	14·36		7·30	7·90
	11.	**12.**	**13.**	**14.**	**15.**
	Buffs from Forfarshire.	Buffs from Mid-Lothian.	Do 1 week later	Do. 2 weeks later.	Ash-leaved Kidney
Dextrin, . .	4·11	1 23	2·78	1·98	trace.
Sacch. matter,	9·81	12·52	12·17	10·70	10·03
	16.	**17.**	**18.**	**19.**	
	Perth Reds.	Cups.	Kidneys from Northumberland.	Seedlings.	
Dextrin, . .	2·30	0·50	} 11·08	} 1·90	
Sacch. matter,	14·27	10·53			

I confess that I cannot find much regularity in these proportions, even when making allowance for the inequality caused by the various proportions of water. There can be little doubt that the differences, which are here perceptible, are caused by the peculiar nature of each variety—by the differences in their respective quantities and extent of cells and vessels, &c. The only purpose, therefore, for which this table can be intended, is to show, that in these, as in the former ingredients, there are differences in the several varieties, which *may* contribute to their different liability to disease.

(*e.*) *In Diseased Potatoes.*

I have already quoted one or two instances of this kind, and will now collect them all into one table:—

Per cent of	1. Red Potato from Ayrshire.	2. Do., more advanced	3. White Potato from E. Lothian.	4. Cups from Mid-Lothian.	5. Cups from Argyleshire.	6. Buffs from Mid-Lothian.	7. Do., one week later.
Dextrin, ...	1 85	1·01	2·12	0 78	4·33	0·53	0·42
Saccharine matter, ...	2 67	6·85	4·57	3·01		2·32	2·26
Calculated Dry—							
Dextrin, ...	9·62	4·78	7·87	3·54	14·63	2·78	1·98
Saccharine matter,...	13 90	32·45	16.18	13·65		12·17	10·70

The three first specimens all contain a remarkably large proportion of dextrin and saccharine matter; in Nos. 1 and 3, that of dextrin, and in No. 2, that of saccharine matter is really enormous, and more than I ever found in any other kind. As, however, these three specimens were of last year's crop, and the four latter of this year, it is possible that either the disease with which the former were affected was of a different character, or that the specimens, when analysed, were in a different stage of disease. At all events, it is remarkable to what extent the proportion of each constituent of the potato is altered by the disease. Still more striking instances of this variety will present themselves when treating of the protein compounds.

(*f.*) *General Average Proportion.*

	In the Natural State.	In the Dry State.
Dextrin, ...	0·55	2·25
Saccharine matter, . .	3 30	13.47

Section 4.—*Proportion of the Protein Compounds.*

These most important and remarkable substances deserve to be considered with peculiar attention. We have thought it necessary to bestow upon them a great deal of care, for reasons which will appear in the sequel.

(*a.*) *Proportion of Albumen.*

Before proceeding to state this in figures, I may be permitted to mention, in general terms, that the quality or peculiar nature of this protein compound seems to be either not always constant, or that it is continually changed during the growth of the plant. If this be the case, then it is not unlikely that the liability of the albumen to undergo changes is in some way connected with the predisposition of the potato to become diseased.

I have at least some reasons to believe, as I will presently state in detail, that in some potatoes which I analysed, either part or the whole of the albumen had at the same time the property of being precipitated by acetic and other acids:—

Per cent of	1. Red Potato from Lanark.	2. White Do., from Argyleshire	3. White Do from East-Lothian.	4. Do., sound part of a dis potato	5. Do., 3 months later.	6. Do., 5 months later.	7. Small American.
Albumen,......	0 75	0 68	0 16	0·20	1·00	trace.	...
Do., cal. dry,..	3·13	3·11	0·80	0·86	3·43	trace.	...
	8. Cups from Argyleshire.	9. Cups from Mid-Lothian.	10. South Americans	11. Ash-leaved Kidneys.	12. Do. Do.	13. Canadians	14. Sound Potato from Orkney.
Albumen,......	trace.	0.12	1·13	1·06	D.0·10	0·98	...
Do., cal. dry,..	...	0 39	5 29	4·96	0·49	2·90	...
	15. Buffs, Forfarshire.	16. Buffs, Mid Lothian.	17. Early Potatoes.	18. Kidneys, Northumberland.	19. Perth Reds.	20. Cups.	21. Seedlings.
Albumen,......	0·56	1·11	D.0 02	D.0·11	D.0·12	1·65	D.0·66
Do., cal. dry, .	1·60	4·41	0·10	0·41	0·47	6·73	3·22

It is a natural consequence of the method in which I determined the albumen, that the quantities found are actually a little above the true ones. During the boiling of the liquid, it is always more or less exposed to the action of the air, and a solution which is so easily changeable, both in colour and composition, as that of the organic part of potatoes, cannot be thus exposed without part of its constituents being converted into apotheme, through the oxidizing influence of the air. This apotheme, being insoluble, is then mixed up with the albumen, and contributes to its dark colour.

In No. 5, I obtained from one-half of the liquid 6·16 grains of albumen by boiling, and from the other half—to which I had previously added acetic acid, to throw down the so called casein, of which, however, there proved to be none present—I obtained only 5·18 grains of albumen, by adding carbonate of ammonia in small excess. Hence I conclude, that about one grain was in a peculiar condition, having neither all the properties of the albumen nor of the casein. On evaporating the remaining liquid, for the purpose of precipitating the dextrin from a concentrated solution, I obtained about 2·75 grains more of some protein compound, including the one grain that had remained in solution. The whole of this, therefore, had probably been changed by exposure to the air at a high temperature, so as to become capable of being precipitated, or rather coagulated, by the action of heat.

No. 6. This specimen was very much shrivelled, quite soft and flexible, and soapy to the touch. It had a hard, bluish spot inside. A piece of it being left for some hours under a glass cover, had obtained a coating of a soot-black appearance, to the

depth of 2 to 3 lines. In this specimen, nearly the whole of the albumen had disappeared.

In No. 10, a similar instance occurred as in No. 5. From one-half I obtained 1·79 grains of albumen by coagulation, and, further, 0·21 of casein by acetic acid; from the other half, which was not heated at all, I obtained, by means of this acid, a quantity of casein, very nearly corresponding to the amount of the albumen and casein in the other half—thus apparently showing, that the mere heating of the liquid had the effect of converting the casein into substances having the property of coagulation, like albumen.

In No. 15, I obtained from the one-half 0·56 per cent of albumen by boiling, and subsequently 0·73 of casein by acetic acid; from the other unboiled half I precipitated by this acid 1·29 of casein, (0.56+0·73=1·29.) The albumen, therefore, seems to have been *produced* during the operation.

In No. 11 and 16, I obtained from the one-half only a very little less albumen by boiling, than there was of casein in the other half. From the boiled part, I could precipitate no casein at all.

It is possible, that circumstances similar to those just mentioned as occurring in the course of my analysis, may have caused variations in the relative proportions of the protein compounds in different varieties of potatoes, although we are certainly not warranted to infer from this, that it was in connexion with the appearance and nature of the disease.

(*b*.) *Proportion of Casein, (so called.)*

	1. Red Potato from Lanark.	2. White Do. from Argyleshire.	3. White do. from East-Lothian.	4. Do., sound part of a dis. Potato.	5. Do., three months later.	6. D. five months later.	7. Small Americans.
Per cent, . .	0·43	0·33	0 07	0.76	0.95	3·04	1·40
Do. calc. dry,	1·89	1·51	0.35	3·26	3.25	7·22	5·10
	8. Cups from Argyleshire.	9. Cups from Mid-Lothian.	10. South Americans.	11. Ash-leaved Kidneys.	12. Do. do.	13. Canadians.	14. Sound Potato from Orkney.
Per cent, . .	0·80	1·49	1·27	1·33	D.1·13	2·65	1·90
Do. calc. dry,	3·18	4·70	5.93	6·23	5·25	7·84	5·44
	15. Buffs from Forfarshire.	16. Buffs from Mid-Lothian.	17. Early Potatoes.	18. D. Kidneys from Northumbd.	19. D. Perth reds.	20. Cups.	21. D. Seedlings.
Per cent, . .	1·05	1·23	0·71	1·53	1·34	0·02	0·81
Do. calc. dry,	2·96	4·90	3·84	5·67	5·13	0·09	3 95

On comparing these results with the proportions of albumen, as presented in the former table, we perceive, that in the greater number of instances the quantities in the latter surpass those in the former table. I must, however, remark, that the coagulum, which I always obtained during the evaporation of the remaining liquid, after having removed the albumen by boiling, and the casein by acetic acid, was considered casein. It was not albumen originally, else it would have appeared by boiling in an almost closed flask; and as it contained nitrogen, I considered it as a protein compound, which could scarcely have been any thing else than one analogous to casein, although it is certainly true, that then it ought to have appeared on the addition of acetic acid to the cold liquid, before evaporating. Probably it was mixed with a good deal of so-called extractive matter. Be this as it may, I will give the proportions of the part, that neither appeared by boiling nor by means of acetic acid. They are as follows:—

	5.	6.	7.	8.	10.	11.	13.	14.	15.
Calculated dry,	0·43	1·31	0·15	0·18	1·09	1·33	1·42	0·71	0·32
	1·47	3·11	0·55	0·71	5·10	6·23	4·20	2·03	0·91

In Nos. 10, 11, and 13, the quantities are considerable, and I have no doubt that these contained a portion of non-nitrogenous extractive matter; for the quantity of protein compounds, as determined by ultimate analysis, proved to be much less than will be obtained by adding up the albumen and casein.

Of the quantity given under No. 14, 0·52 was decidedly casein, which, being boiled, had lost the property of being precipitated by acetic acid. In this instance, the casein in the unboiled half appeared suddenly in large flocks on the addition of acetic acid, and fell to the bottom very quickly; but in the boiled half, although appearing quickly, it was *exceedingly* slow in falling. When it had fallen at last, part was lying on the bottom of the vessel, more gelatinous than flocky; above this was a layer of clear liquid, and above this again a thick homogeneous film, convex on the upper surface.

It is further remarkable, how in Nos. 3, 4, 5, and 6, all belonging to the same kind of potato from one field, not only the whole quantity of soluble protein compounds had been altered, but, at the same time, the relation between the quantities of albumen and casein. In Nos. 3 and 4, we see no difference in the proportion of albumen; but that of casein in No. 4, is nearly ten times as great as that in No. 3. Further, on looking at Nos. 5 and 6, we perceive that the albumen has been quadrupled

in No. 5, and that in No. 6 it has nearly entirely disappeared; and, as regards the casein, this is the same in Nos. 4 and 5, but in No. 6 it is more than doubled.

(c.) Proportions in Diseased Potatoes.

	1. White Potato from Ayrshire.	2. Do, more diseased.	3. White Potato from East-Lothian.	4. Cups from Argyle-shire.	5. Cups from Mid-Lothian.	6. Buffs from Mid-Lothian.	7. Do, 1 week later.
Albumen,	0·57	0·87	2 26	0 08	0·34	0 60	0·92
Casein,	0·38	0·55	0·23	0·78	1·49	1·22	0·90
Calculated dry—							
Albumen,	2 97	4·12	8 00	0·27	1·54	3·15	4·35
Casein,	1·97	2 61	0 81	2·63	6·80	6·41	4·26

The greater amount of soluble protein compounds in No. 2, compared with No. 1, is striking, especially when viewing it in connexion with the property of potatoes that either are diseased, or pre-disposed to become so, of rapidly emitting shoots. We should remember at the same time, that the solubility of these compounds is a requisite for this vegetation, as explained before.

The quantity of soluble protein compounds is still greater in No. 3.

In No. 4, however, it is a little smaller than in the sound cups that formed part of the same crop; but we here find a little albumen, which was almost wholly wanting in the other. The disease in these cups was only just beginning to appear. Contrary to what I usually observed, the casein fell down much quicker from the half that had been previously boiled, than from the other half.

In No. 5, when compared with No. 9, of the two former tables, we perceive that the proportion of albumen has become triple, whilst that of casein remained apparently constant. But when we look at the results, as calculated in the dry state, we find that there actually was a fourfold quantity of albumen, and about the half more of casein in the diseased specimen, the whole difference amounting to 3·20 per cent.

Between Nos. 6 and 7 we find this difference, that the latter contains about 1 per cent of soluble protein compounds less than the former, but fully 1 per cent of albumen more. It would appear, therefore, that there was here a tendency to form soluble albumen, analogous to what we saw in Nos. 1 and 2, and also in No. 3, when compared to Nos. 3 and 4, of the two former tables;

for there we find a *tenfold* increase of albumen, and between No. 4 in the former, and No. 3 in this table, we perceive a great decrease of casein.

(d.) Total Protein Compounds, ascertained by burning.

1st, in the tuber.

These experiments were undertaken with the view of determining, as accurately as necessary, the proportion of nitrogen, since in this manner, from the known composition of protein, the latter could be correctly calculated.

The process which I have adopted, is the well-known method named after MM. Will and Varrentrapp. It is less accurate than to determine the nitrogen by measure; but is correct enough for my present purpose, and preferable on account of its comparative quickness and facility, no immaterial point, when a considerable number of determinations are required.

1°. *In the Tuber.*

(a.) Sound.

	1. Red Buffs from Mid Lothian	2. White Potato from East-Lothian	3. Buffs from Forfarshire	4 Ash leaved Kidneys.
Nitrogen, per cent,......	0·556	0·33	0·40	0·26
Do. calculated dry,...	2·21	1·13	1·14	1·23
Equal to Protein compounds, per cent,......	3·50	2·07	2·50	1·64
Calculated dry,..........	13·89	7.10	7·14	7·70
	5. White Potato from Dumbartonshire	**6. Cups from Argyleshire**	**7. Canadians**	**8. Small Americans.**
Nitrogen, per cent,......	0·508	0·33	0·50	0·35
Do. calculated dry,.....	1·54	1·33	1·27	1·27
Equal to Protein compounds, per cent, ...	3·19	2·10	3·19	2·19
Calculated dry,.........	9·68	8·34	9·46	8·00

On examining these results, we may make the following remarks—

The variations in the amount of protein compounds in different varieties of sound potatoes, although very apparent, are less than that existing between the proportions of starch. The buffs from Mid-Lothian do not properly belong to this place, as they became diseased a few days afterwards. They may serve

here as an illustration, and be compared with the proportions in the other varieties.

(b.) Diseased.

	1. Red Buffs from Mid-Lothian	2. Do, 1 week later	3. Cups from Argyleshire
Nitrogen, per cent,.......	0.556	0.36	0.65
Do. Calculated dry,....	2.21	0·89	2.21
Equal to protein compounds,.......	3.50	2·26	4.11
Do. calculated dry,.....	13.89	11·87	13·88

This table shows a remarkable increase of protein compounds compared with those in sound potatoes. The differences between Nos. 1 and 2 may *possibly* be accounted for by the difference which we may always expect to exist, *to some extent*, between various plants in the same field; but the close correspondence between Nos. 1 and 3, which were different varieties from very different localities, is remarkable.

(c.) In different parts.

	White Potato from East-Lothian			Buffs from Mid-Lothian 15th Aug.			Do., 22d Aug.			Cups from Argyleshire. Sound.		Cups from Argyleshire. Diseased	
	1	2	3										
	Centre	Vascular ring	Epidermis	Rose end	Centre	Heel end	Rose end.	Centre	Heel end	Rose end	Heel end.	Rose end.	Heel end.
Nitrogen per cent,	0.60	0.63	0.42	0.389	0.32	0.567	0.2[illegible]5	0.29	0.25	0.46	0.44	0.47	0.478
Do, calculated dry,	1.57	1.91	1.[illegible]2	2.235	2.14	2.25	1.48	1.886	1.377	1.94	1.72	1.67	1.45
Equal to Protein compounds,	3.78	3.98	2.65	2.416	2.01	3.56	1.48	1.81	1.66	2.91	2.75	2.96	3.01
Do, calculated dry,	9.90	12.01	11.13	14.06	13.50	14.14	9.30	11.86	8.66	11.60	10.93	10.50	9.14

We here perceive more or less sensible variations between the two extremities of the tuber, whilst that of the centre is still greater. On the 15th August, the centre contained less than the two ends. Then, or soon after, the disease appeared, and had become very visible on the 22d, at which date we perceive that the protein compounds in the centre decreased, but so much less than in the two ends, that it now contains more than either of them.

In Nos. 1, 2, and 3, we perceive the centre to contain least,

and only a small difference between the epidermis or skin, and the vascular ring immediately underneath.

Whatever conclusion may be drawn from these results, it appears certain that the proportion of protein compounds varies in different parts of the potato, and it can scarcely fail to appear probable, that this is connected with the physiological nature and functions of these several parts, and the organisation of the whole tuber. If it be found, as I shall endeavour to establish by further investigations, that the rose end contains a greater quantity of protein compounds than the opposite extremity of the tuber—which seems to be generally richer in starch—then we should be almost induced to connect this with the more rapid and abundant sprouting of the eye or rose end, than that of the other extremity.

(*d.*) *In different periods.*

	Red Buffs from Mid-Lothian.					
	Old Sets.		New Tubers.			
	1. May 30.	2. June 13.	3. Aug. 8.	4. Aug. 15.	5. Aug 22	6. Aug. 29
Nitrogen, per cent,	0·156	0·038	0 26	0·556	0·36	0·336
Do., calculated dry,	1.35	1·16	1·46	2·21	1·89	1·59
Protein, per cent,	0·987	0·239	1·65	3·50	2·26	2·12
Do., calculated dry,	8.51	7·30	9·21	13·89	11·87	10·02

I confess I was a little surprised to find, on repeated analysis, the quantity of protein compounds so little diminished in the old sets as they had, especially at the last-named date, produced remarkably tall plants. It would appear from the complete organic analysis, which I shall give in the following section, that the greater part of this quantity was in an insoluble state; and, in fact, had it been otherwise, then the sets could not very well have been lying in the soil for any length of time, without these compounds being washed out by the moisture. On the 8th of August the potato was still unripe, and yet the proportion of protein compounds reached the usual amount; on the 15th, when it could scarcely be yet called ripe, the figure 9·2 increased to 13·9; between this and the 22d, the disease set in, and became distinctly visible, and still more so on the 29th; and we perceive, at the same time, a constant diminution of protein compounds.*

2°. *In the Fibre.*

	1. Buffs from Mid-Lothian, 8th Aug.	2. Do., 15th Aug.	3. White Potato from East-Lothian.	4. Do., 2 months later.	5. Potato from Orkney.	6. Buffs, Forfarshire.	7. Ash-leaved Kidneys.	8. Cups, Argyleshire.	9. South Americans.	10. Canadians.	11. Small Americans.	12. White Potato from Argyleshire.
Calc. dry— Nitrogen,	0·83	0·93	0·50	0 57	0·52	0 57	0 73	0·52	1·01	0·58	0 52	0·55
Protein compound,	5·23	5 87	3 08	3 60	3 21	3 55	4·62	3·18	6·31	3 64	3·21	3·43

The average proportion of nitrogen in the fibre of sound potatoes, representing the glutin and coagulated albumen, appears to range between 0·5 and 0·7 per cent in the dry fibre, equal to 4 and 5 per cent of insoluble protein compounds; that is, about 1 per cent of the dried potatoes, or 0·2 to 0·25 per cent in potatoes in their natural state. The higher figures, in Nos. 1 and 2, were obtained from potatoes that became naturally diseased the next week, and must, therefore, have been in an unhealthy condition. Those under No. 9 were of a small size, and very deficient in starch, as we have already remarked.

3°. *In the Shoots.*

I have only been able, as yet, to determine the nitrogen in shoots from one kind of potato in different periods; viz. those of the white variety from East-Lothian, which I had made to sprout in a box.

	1. April 26.	2. May 7.	3. June 8.	4. June 20.	5. July 7, from Heel end.	6. July 7, from Rose end.
Nitrogen per cent, .	0·436		0·28	0·457		0 80
Do., calculated dry, .	2·96	3·14	3·51	3·25	3·09	3·25
Equal to protein compound per cent, .	2·76		3·98	2·87		
Do., calculated dry, .	18·67	19·72	22·09	20·41	19·41	20·44

The increase in the protein compounds is here not regular, which may partly be attributable to the shoots having been taken

from various specimens, although of the same variety. But the large quantity of these compounds in potato shoots, compared with that in the tubers themselves,* appears to be one cause why the vital powers of the latter are so much weakened by sprouting. Then they emit shoots, which contain a greater amount of those important ingredients than they themselves, and which cannot have derived them from any other source than from the tuber.

(e.) *Decomposition of Protein Compounds in the Diseased Potato.*

When a diseased potato is cut through, and a piece of red litmus paper placed between the two halves, which are immediately put together again, the blue colour of the paper will gradually reappear. When the same is done with a sound potato, taking blue litmus paper, the latter will gradually become slightly red. A diseased potato, therefore, has an alkaline, a sound potato has an acid, reaction.

Whence arise these alkaline and acid reactions? The latter may find an explanation in the nature of the organic salts, of which I, in a few instances, found the acid to be *citric acid*—whilst others have stated that they had discovered malic, and even tartaric acid. These acids are inclined to form acid salts; and if, therefore, all the other ingredients neutralize each other, an acid reaction must take place to a greater or less extent.

If we consider, on the other hand, how easily the protein bodies are decomposed; that the somewhat protracted action of potash or soda is sufficient to make them disengage ammonia; that hydrochloric acid converts them into humate of ammonia; and that the mere exposure of a not very weak solution to the atmosphere, is sufficient after some time to decompose them, and to change them gradually into ammoniacal salts; then it seems to follow as a natural consequence, that when the liquid within the cells of the tuber is more than usually charged with these protein compounds in a soluble state, in contact with alkaline salts, a similar decomposition will take place as we can so readily produce by artificial treatment. It would be out of place here to illustrate these decompositions by means of formulas, as it would be imprudent to engage in any further theoretical deductions. I would merely state the fact here in connexion with the results presented in the last table.

* This fact will cease to appear strange, if we bear in mind that the shoots derive both their nitrogenous and non-nitrogenous constituents from the tuber and that, when they take a smaller proportion of the latter, the former must predominate in them.

Section 5.—*General Composition of the Organic Part of the Potato.*

I shall first give a number of complete organic analyses, and after that the calculated average of every one of the constituents.

	Water.	Starch.	Dextrin.	Saccharine matter.	Albumen.	Casein.	Glutin.	Fat.	Fibre.
Red Potato from Lanark	76.07	14.08	0.71	3 11	0.75	0.43	0.10	0.31	3.67
Red Potato from Ayrshire, sound part	78.13	13.08	0.62	3.43	0 68	0.33	0.56	0.16	2.34
Do. do. diseased part	75.89	6 08	1.01	6.85	0.87	0.55	0.32	0.19	4 99
Do. do. diseased potato	80.78	11.01	1.85	2.67	0.57	0.38	0.28	0.20	2.12
White Potato from East-Lothian, sound	[illegible]	12.24	0.38	2 32	0.16	0.07	0.42	0.21	3.77
Do do. sound part	76 72	14.32	0 33	2 63	0.20	0.76	0.46	0.52	3 98
Do. do. diseased part	71.77	14.59	2.12	4.57	2.26	0.23	0.44	0.44	3.48
Do. do. sound, 3 months later	70 31	16 73	..	4.11	1.00	0.95	...	...	5 69
Do. do. do. 5 months later	57 91	21.[illegible]	1.09	7.37	trace	2.44	...	...	0.67
White Potato from Argyleshire	67 [illegible]	18.07	0.11	3.14	0 05	1.47	0.27	0.36	0.97
Small Americans	72 58	17.80	0.13	3.21	...	1.40	0.11	...	4 54
Cups from Argyleshire, sound	74.83	15.14	...	2.58	trace	0.89	0.19	...	4.34
Do. do. diseased	70.41	18 42	...	4.33	0.08	0 78	...	...	5.66
Cups from Mid-Lothian, sound	68 28	23.82	0.91	2.32	0.12	1.37	...	...	3 46
Do. do. diseased	77 95	14.27	0.78	3.01	0.34	1.49	...	...	2 93
South Americans	78.59	8.14	0.30	5.12	1.13	1.27	...	...	4.83
Ash-leaved Kidneys	78.64	9.52	0.18	4.51	1.06	1.33	...	...	4.23
The same variety D.	80.46	14.93	trace	1.96	0.10	1.13	...	...	1.49
Kidneys from Northumberland, D.	73.05	18 23	...	2.99	0.11	1.53	0.03	...	4.48
Grey's Kidneys Rose-end, D.	76.56	14.84	0.14	2.70	0.06	1.97	...	...	2.84
Do. do. Middle, D.	75.20	13 97	...	1.78	0.04	1.71	...	...	2 94
Do. do. Heel-end, D.	71.78	17.48	0.19	2.76	0 04	1.99	...	...	3.40
Belfast Rounds, Rose-end, C.	70 73	19 16	0.18	1.70	0.18	0.83	...	...	7.13
Do. do. Middle, C.	80.03	14.40	0.07	1 70	0.31	0 90	...	...	3.67
Do. do. Heel-end, C.	69.89	18.70	0.40	3.27	0.49	1.10	...	...	3.33
Red Potato from Argyleshire, Rose-end, C.	74.31	16.42	...	2.30	...	1.30	...	...	5.67
Do. do. Middle, C.	80 66	13 73	...	1 10	...	1.23	...	...	3 29
Do. do. Heel-end, C.	72 06	20 93	...	1.86	...	1 04	...	...	4 11
Cups (place not known)	75 51	15 94	0.12	2 55	1.65	0.02	...	...	1.75
Canadians	66.23	20 92	0 95	2.60	0 9[illegible]	2.65	...	...	6.41
Sound Potato from Orkney	65.09	17 42	0 91	5.01	...	1.71	...	...	8 41
Buffs from Forfarshire	64.94	20.71	1.41	3.44	0.50	1.05	...	...	7.38
Shoots of the same	81.91	1.37	0.82	7 13	0.86	3.36	...	...	2.75
Buffs from Mid-Lothian, old sets	88 41	5 50	0 08	2.97	0 24	0.26	...	...	2.35
Do. do. a fortnight later	96.46	0 05	0 09	2 50	0.05	0.30	...	...	1.51
Do. new Potatoes	82.88	5.33	0.85	3.97	0.75	0.20	...	...	4.35
Do. a fortnight later	82.01	7.51	...	2 88	0.34	0.67	...	...	4.69
Do. week after (15th August)	74 83	14.89	0.31	3.15	1 11	1.23	...	...	4.45
Do. do. (22d August)	80 94	10.40	0.53	2.32	0.60	1.22	...	...	4.33
Do. do. (29th August)	78.86	11.07	0.42	2.26	0.92	0.90	...	...	4.69
Early Potatoes D.	81.49	9.14	0.27	2.26	0.02	0.71	0 21	...	4.87
Perth Reds D.	73.85	16.53	0.60	3.73	...	1.34	0 12	...	3.63
Seedlings D.	79.48	...	...	0.39	0.66	0.81	...	...	3.15

Leaving out of account the diseased specimens, and those that

were not yet full grown, we may represent the general average composition of the organic part of cultivated potatoes by the following numbers :—

	In the natural state.		In the dry state.
Water, ...	75 52	...	
Starch, ...	15 72	...	64.20
Dextrin, ...	0 55	...	2 25
Saccharine matter, (impure,)	3 30	...	13.47
Albumen, Casein, Glutin, }	1.41	...	5.77
Fatty matter, ...	0 24	...	1 00
Fibre, with coagulated albumen,	3 26	...	13 31

Mean of results obtained by Einhoff, Lampadius, and Henry :—

			In the dry state.
Water, ...	75.28	...	
Starch, ...	14.25	...	58.12
Dextrin, Saccharine matter, &c. }	2.02	...	8 24
Albumen, Casein, } . . .	1.10	...	4 50
Fibre, (glutin and fat,) .	7 12	...	29 14
	99.77		100.00

I find it difficult to account for the enormous proportion of fibre, compared with the results given in this paper.

SECTION 6.—*Comparative value of the Potato, as food for man.*

(a.) Dry Potato compared with Oats, Wheat, Indian Corn, Rye, Barley, Rice, Pease, and Beans.

	1. Potato.	2. Wheat. (Bouss.)	3. Oats (Norton.)	4. Rye. (Bouss.)	5. Barley. (Hermbst.)	6. Rice (Payen.)	7. Indian Corn. (Payen.)	8. Peas (Bouss.)	9. Beans (Bouss.)
Starch, . . .	64 20	73 8	65 27	64 00	68 7	86 9	71 2	52 0	44 0
Dextrin, . .	2 25	4 7	2 24	11 00	5.0			5 5	5 0
Sacch. matter,	13 47	7 0	2 25	3 60	5 3	0 5	0 4	2 2	2 3
Albumen, . .			1 42						
Casein, . . .	5 77	13.5	19 65 { 16 35	10 5	6 0	7 5	12 3	22 6	31 4
Glutin, . .			1 66						
Fatty matter, .	1 00	?	6 57	3 5	0 3	0 8	9 0	2 2	2 3
Fibre or husk,	13 31	1 00	2 18	8 0	14 7	3 4	5 9	12 2	11 5
Salts and loss,	..	...	1 84	..	...	0 9	1 2	3 3	3 5

We see from this table that the several substances will rank differently, according to the kind of ingredients to which we look for comparison.

If, for instance, we take the protein compounds, we have—

Beans, peas, oats, wheat, Indian corn, rye, rice, barley, potatoes.

Whilst the starch gives the following arrangement—

Rice, wheat, Indian corn, barley, oats, potatoes, rye, peas, beans.

The gum and saccharine matter—

Potatoes, rye, wheat, barley, peas, oats, beans, rice, Indian corn.

The fat—

Indian corn, oats, rye, beans, peas, potatoes, rice, barley, wheat.

And the fibre—

Barley, potatoes, peas, beans, rye, Indian corn, rice, oats, wheat.

This fibre, it will be remembered, includes the coagulated albumen, but otherwise it may be considered of little or no value as food.

But looking at each of these columns as a whole, and comparing that of potatoes with each of the others, in a general point of view, I would feel inclined to propose the following arrangement:—

Beans,	100
Peas,	80
Oats,	75
Wheat,	70
Indian corn,	60
Rye,	55
Barley,	50
Potatoes,	45
Rice, .	35

This means, that the general feeding properties of peas are to those of beans in nearly the same ratio as 80 to 100, &c. It is evident that such a valuation can only be approximative, for the composition of these esculents just given is by no means constant.

(b.) Use of the Starch and Fibre as Food for Man and Cattle.

The former of these ingredients is frequently represented as the means of keeping up respiration, and, through it, the heat of the animal body. Every one who, with the necessary knowledge, has the power of thinking and reflecting, has a right to judge for himself, and I will therefore say nothing against this theory—not even referring to the complexity of the animal functions, which render it improbable that such a direct purpose should be

served by the starch, on account merely of its consisting of carbon and the elements of water. It is, at the same time, very difficult for any one closely to investigate this matter. Certain it is, however, that starch serves a very important purpose in the animal economy. Its easy transformation into gum and sugar—the solubility of the latter—the liability of the sugar to undergo fermentation, and thus partly to be converted into gaseous products, and its fitness for combining with several animal substances even within the body—the formation of gelatine sugar, which contains nitrogen, and thus seems to form a natural transition to the nitrogenous or protein compounds;—all this tends to show the very great importance of starch as a feeding substance.

As regards the potato fibre, this is almost always thrown away or neglected as refuse, after the starch has been extracted from it. From what I have stated before as to the average quantity of protein compounds which it contains, it will be seen at once how erroneous and disadvantageous such a neglect is. Every 100 lbs. of dry potato fibre contains on an average 4 lbs. of protein compounds, besides a quantity of inorganic constituents, and is therefore, in this respect, equal to about 50 lbs. of dried potatoes. It would only be required to mix this fibre with some other esculent of a more palatable nature, to render it valuable as an article of food.

I shall conclude this division of my subject by remarking, that the potatoes lost their white colour on exposure to the air, and the sooner the longer they had been allowed to sprout. They became rust-coloured, dark-brown, and even black. These were in no way affected with disease. The fibre appeared each time coarser, and the starch approached gradually to the appearance of gum. It always remained insoluble in water, but before being dried, and whilst still diffused in the water, it became more and more like a pulp, and lost its usual granular appearance. The colour of the juice of the potato was similar to that assumed by the cut potato itself on exposure to the air; but when the change of colour in the potato was small, that of the juice remained unaltered, and of a pale yellow colour.

II.—OF THE INORGANIC PART OF THE TUBER.

Section 1.—*Of the proportion of Ash left by the Potato Tuber.*

(a.) By the Young Tuber.

	1. Buffs from Mid-Lothian.	2. South American.	3. Ash-leaved Kidneys.
Ash per cent, . .	0 80	1.16	0.95
Do. calculated dry, .	4.32	5.42	4.45

The proportion of inorganic matter varies, as may be seen from these few examples. This may possibly depend upon their various stages of growth.

(b.) The Full-Grown Tuber.

	1. Buffs from Mid-Lothian.	2. Red Potato from Lanark.	3. White Potato from East-Lothian.
Ash per cent, . .	0.78	0.96	0.75
Do. calculated dry, .	3.36	4.01	3.75

There is not a great difference in these three varieties of sound and full-grown potatoes. On comparing No. 1 with the same number in the former table, which indicates the same variety, but not full-grown, we perceive a decrease of about 1 per cent in the ripe potato. The difference in their several proportions of water, is the cause why this decrease is only apparent when the ash is calculated in the dry state.

(c.) In Successive Periods of Growth.

	Butts from Mid-Lothian.							
	Old Sets.			New Potatoes.				
	1. May 30.	2. June 13	3. June 27.	4. July 25	5. Aug. 8.	6. Aug. 15	7. Aug 22	8. Aug. 29
Ash per cent,	0·64	0·65	0·705	0·80	0·70	0·78	0·79	1·93
Do. Calculated dry, . . .	5·52	19·88	12·94	4·32	3·90	3·36	4·70	5·35

When looking at this table, we find:—

1°. That the proportion of ash varies considerably in the old sets. The difference between Nos. 1 and 2 is not apparent in

the wet state of the set, but the enormous difference, when calculated dry, solely depends upon the different proportions of moisture. It would appear as if the old potato served as a concentrating medium, where the liquid from the soil, before rising into the stem, stays for some time, as if to solve the salts peculiar to the potato plant, and to carry them up, along with those which it extracted from the soil itself. We actually perceive a decrease in No. 3; or rather, part of the water, charged with salts, has disappeared, and been replaced by a smaller quantity of liquid, containing a less proportion of inorganic salts. The latter is in accordance with the phenomena and laws of endosmose.

2°. That the potato, in its very youngest stage, (No. 4,) is not only charged to a greater extent with liquid, but that the greater quantity of liquid which it now contains, compared with that in a later period, is charged with a greater proportion of inorganic salts, which were perhaps for the most part directly extracted from the soil by means of the fibrillæ. A fortnight later, (No. 5,) we perceive a decrease in this proportion of salts, and it only increases again when the disease becomes distinctly apparent, (Nos. 7 and 8.) This must again have arisen from the presence of an additional quantity of liquid, over and above that, which was contained in it before, (No. 6,) charged with a larger proportion of these salts.

(d.) By different varieties of Potatoes.

	1.	2.	3.	4.	5.
	Buffs from Mid Lothian.	Buffs from Forfarshire.	Cups from Argyleshire.	Cups from Mid-Lothian.	White Potato from E. Lothian.
Ash, per cent,	0·78	1·08	0·99	1·16	0·75
Do., calculated dry, . . .	3·36	2·68	3·93	3·70	3 75
	6.	7.	8.	9.	10.
	Red Potato from Ayrshire.	Red Potato from Lanark.	The same as No. 5, three months later.	Do. 5 months later.	White Potato from Dumbartonshire.
Ash, per cent,	1·03	0·96	1·10	1·27	0·76
Do., calculated dry, . . .	4·71	4 01	3·77	3·02	2·30
	11.	12.	13.		
	Small Americans.	Canadians.	White Potato from Orkney.		
Ash, per cent,	0·94	1·24	1·58		
Do., calculated dry, . . .	2 68	3·80	4·53		

1°. When comparing together Nos. 5, 8, and 9, we perceive

that the effect of the production of shoots upon the inorganic salts, did not become apparent until about five months after the first determination was made. Considering the small weight and bulk of these shoots compared with those of the entire tuber, this decrease appears considerable. By the decrease in the quantity of liquid in the potato, this diminution of inorganic matter is represented as an increase.

2°. There is no determined proportion of inorganic salts in the different varieties of potatoes. In fact, the various kinds of soils and manures, taken in connexion with the different nature of each individual variety itself, does not make it likely that this should be the case. From this table it seems to range between 2·68 and 4·71, and as the average might be represented:

For the dry potato, at . . .	3.57	per cent of inorganic matter.
Do., in the natural state, . . .	0·87	

(e.) By diseased Potatoes.

	Cups from Mid-Lothian.		Cups from Argyleshire.		White Potato from East-Lothian.		Red Potato from Ayrshire.		Buffs from Mid-Lothian.	
	1. Sound.	2. Diseased	3. Sound.	4. Diseased	5. Sound.	6. Diseased	7. Sound.	8. Diseased	9. Sound.	10. Diseased
Ash per cent,	1·16	0·87	0·99	1·08	0·73	0·82	1·03	1·40	0·78	1·13
Do. calculated dry, . .	3·70	3·96	3·93	3·65	3·75	2·91	4·71	6·63	3·36	5·35

There seems to be no regular relation between the diseased state of the tuber and the proportion of inorganic salts which it contains. For although No. 8 shows an increase when compared to No. 7, a decrease is shown in Nos. 6 and 4 compared with Nos. 5 and 3. It is, however, of some interest to view this increase in the diseased potato, in connexion with what took place at successive periods of growth. (*Table*, p. 673, Nos. 6, 7, and 8.)

(f.) By different Parts.

	Buffs from Mid-Lothian grown in the Soil.												
	25th July.		8th Aug.		15th Aug.			22d Aug.			29th Aug.		
	Heel end.	Rose end	Heel end.	Rose end.	Heel end	Rose end.	Centre.	Heel end.	Rose end.	Centre.	Heel end.	Rose end.	Centre.
Ash per cent,	0·73	0·85	0·79	0·79	0·92	0·88	0·88	0·73	0·98	0·70	1·10	1·29	0·86
Do. calculated dry, . .	3·70	4·97	3·40	4·20	3·65	5·06	5·92	3·81	6·16	4·58	4·33	6·90	5·73

	White Potato from East-Lothian, sprouted in a box without earth.													
	5th Mar.		23d Mar.		6th April.		7th May.		8th June.		20th June.		7th July.	
	Heel end.	Rose end.	Vasc. ring.	Epiderm	Heel end.	Rose end.	Heel end.	Rose end.	Heel end.	Rose end.	Heel end.	Rose end.	Heel end.	Rose end.
Ash, . .	0·68	0·94	1·02	1·91	0·64	0·65	0·71	1·30	1·23	1·44	0·97	0·95	0·84	1·21
Do. dry,	2·22	3·11	3·10	8·23	2·02	2·08	1·90	3·97	3·83	4·57	2·54	2·30	1·71	2·46

	Buffs from Mid-Lothian, from a pit.				White Potato from Dumbartonshire.				Small Americans.			South Americans.	
	Heel end.	Rose end.	Heel end.	Rose end.	Heel end.	Rose end.	Vasc. ring.	Epi-derm.	Heel end.	Rose end.	Epi-derm.	Heel end.	Rose end.
Ash, . . .	0·63	0·93	0·59	0·77	0·87	1·05	1·09	1·85	0·83	1·01	1·76	1·34	1·33
Do. dry, . .	2·64	3·78	4·95	6·93	2·60	3·63	3·20	7·71	2·86	4·24	9·33	6·20	6·26

	Cups from Argyle-shire.				Ash-leaved Kidneys.		Canadians.		Buffs from Forfarshire.		Potato from Orkney.	
	Sound.		Diseased.									
	Heel end.	Rose end.	Heel end.	Rose end.	Heel end.	Rose end.	Heel end.	Rose end	Heel end.	Rose end.	Heel end.	Rose end.
Ash per cent,	1·02	1·13	1·10	1·26	1·08	1·04	1·01	1·00	1·16	1·55	1·60	1·94
Do. calculated dry, . . .	4·01	4·51	3·33	4·47	4·68	5·78	2·73	2·81	3·17	4·63	4·12	5·10

	Early Potatoes from Renfrew-shire. D.			Perth Reds. D.			Cups.			Kidneys from Northumberland. D.		
	Heel end.	Mid-dle.	Rose end.	Heel end.	Mid-dle.	Rose end.	Heel end.	Mid-dle.	Rose end	Heel end.	Mid-dle.	Rose end.
Ash per cent,	0·93	0·87	1·18	1·38	0·90	1·16	0·53	0·49	0·96	0·72	0·75	1·63
Do. calculated dry, . . .	5·03	3·93	6·10	5·32	4·32	3·32	2·90	2·44	3·43	2·07	2·86	8·18

	D. Grey's Kidneys.		
	Heel end.	Middle.	Rose end.
Ash per cent, . . .	1·10	1·07	1·33
Do. calculated dry, . .	3 89	4·33	5·25

Nearly every one of these numerous results was the mean of

three determinations. I have consequently tolerable evidence for assuming as *general* facts:—

1st, That the proportion of inorganic matter is greatest in the rose end.

2d, That this relation exists during the successive periods of growth.

3d, That the centre contains the smallest proportion of inorganic matter.

4th, That potatoes, whilst sprouting, if not placed in the soil, are continually losing their inorganic constituents; but that the latter increase in quantity when the tubers are sprouting in the soil.

5th, That the proportion of inorganic matter in the vascular ring nearly coincides with that in the rose end.

The two potatoes, taken from a pit, had severally produced a shoot, of which the one was fully twice as long as the other. In the one which had produced the longest shoot, the increase of inorganic matter in the rose end was also greatest.

6th, That the epidermis contains a greater proportion of inorganic matter than any of the other parts of the tuber.

7th, That in the two varieties from America, the Canadians and South Americans, the proportions of inorganic matter in the heel and rose-end are nearly the same.

Let us see in how far may be applied these facts in the explanation of the growth and nature of the potato.

The tuber of the potato is an organic whole, ready to propagate itself whenever circumstances are favourable for its reproduction. The requisite for this propagation is, the solubility of the ingredients from which the new parts are chiefly to be formed and sustained, viz. the protein compounds and dextrin. Without the materials being moved towards their destination, they cannot have their effect, and without being dissolved—that is, in a moveable state—they cannot change their position. The connexion between organic and so-called inorganic matter is such, that the former takes always with it such a part of the latter as is necessary for the existence of the new productions. From whatever point, therefore, of a potato-tuber these productions are chiefly emitted, towards that point there will be an extraordinary flow of sap, holding several organic and inorganic substances in solution—or rather the reverse, the flow of liquid being the cause of such productions. The greatest quantity of vessels terminate in the rose end. Through the vessels the flow of sap is least interrupted; and through the vessels, therefore, towards the rose end, the necessary solubility of the protein compounds and dextrin being once effected, an extraordinary quantity of sap, charged with organic and inorganic substances, will

take place. The effect of this is, the production of new shoots. These being once produced, the flow of sap will be constantly increased, and the tuber, as stated in the fourth conclusion, will continually lose, unless there be a possibility of having this last restored, as is the case when the potato is placed in the soil.

That the epidermis should contain such a large proportion of inorganic substances is quite natural; for not only does the flow of sap take place towards the exterior, but there is always going on a greater or smaller evaporation from the epidermis, and the evaporated liquid being pure water, the substances that were held in solution in that water will naturally be deposited chiefly in the epidermis.

In how far the rapid sprouting of more or less diseased potatoes is in connexion with a very rapid flow of highly charged sap, I will not venture here to say.

SECTION 2.—*Composition of the Ash of the Potato Tuber*

(a.) Of different varieties of Potatoes.

I can as yet only offer the four following analyses:—

	Grey's Kidney from Inverness.	Red Potato from Lanark.	White Potato from East-Lothian.	Red Potato from Ayrshire.
Potash,	D. 52·88	44·78	41·89	40·56
Soda,	...	2·85	1·63	6·51
Lime,	0·53	0·63	2·79	1·15
Magnesia,	2·59	3·52	4·24	2·93
Oxide of iron,	0 17	0·32	0·47	0·35
Phosphoric acid,	5·13	7 76	12·28	9·10
Sulphuric acid,	19·12	11·38	15·20	14·69
Carbonic acid,	12 29	22·13	15·76	16·60
Chlorine,	4·82	4·01	3 80	7·67
Silica,	0·53	2·86	2·10	1·04
	98·06	100·24	100·16	100·60

The carbonic acid, which is set down here, is of course a product of combustion, and is chiefly derived from the organic acids in the tuber. I have, contrary to the general custom, left it in here, because otherwise the ratio between the several bases and acids would be entirely destroyed.

(b.) *Of Diseased Potatoes.*

	White Potato from East-Lothian.		Red Potato from Ayrshire.	
	Sound part.	Diseased part.	Sound part.	Diseased part.
Potash,	45·47	40·42	40·56	38·98
Soda,	1·81	5·80	6·51	7·00
Lime,	0·85	1·62	1·15	0·94
Magnesia,	1·98	2·81	2·93	2·62
Oxide of iron,	0·60	0·87	0·35	0·72
Phosphoric acid,	5·31	7·96	9·10	11·92
Sulphuric acid,	19·70	12 31	14·69	12·94
Carbonic acid,	18·69	21·25	16·60	16·88
Chlorine,	3·76	0·17	7·67	6·35
Silica,	1·77	6·33	1·04	2·30
	99·94	99·54	100·60	100·65

I will postpone the few remarks that I have to make upon these latter to a following section.

(c.) *Of different parts.*

	Buffs taken from a Pit.	
	Rose end.	Heel end.
Potash,	38·15	29·53
Soda,	5·40	11·26
Chloride of sodium,	6·25	9·66
Lime,	1 28	1·55
Magnesia,	5·90	3·96
Oxide of iron,	1·03	1·34
Sulphuric acid,	24 32	20 63
Phosphoric acid,	12·81	20·73
Silica,	4 86	1·34
	100·	100·

If further investigations, which I propose to make should confirm these results, it would lead to interesting deductions. At present I avoid dwelling upon these, and wish merely to point out that there *is a difference* between the composition of the different parts of a potato.

The examination of the ash of potato fibre produced the following result:—

Potash and soda with a little common salt,	3 72
Sulphate of lime,	6·77
Lime,	48 00
Magnesia,	10 21
Oxide of iron,	3 82
Phosphoric acid,	19 66
Do. Do. combined with alkalis,	1·81
Soluble silica,	0 67
Insoluble silica,	4 87
	99 53*

The greaters part of the lime was in the state of carbonate. It is remarkable how much greater the quantity of lime is here than that of magnesia; in the ash of whole potatoes the reverse takes place. The juice, therefore, seems to contain a much greater proportion of magnesia than of lime.

The analysis of the ash of another kind of fibre produced—

D.	Carbonate of lime,	39 75
	Phosphates, containing 20 00 per cent of lime,	44 72
	Alkaline salts,	15 39
	Silica,	0 14
		100

SECTION 3.—*Peculiarities in Potatoes, as compared with those of other Crops.*

The potato is characterised by some remarkable properties, which it is of importance to know. If they are, and always had been properly attended to, perhaps a safer guidance would have been obtained than mere empirical rules, and the plant would in many cases have been treated in a way more consistent with its nature.

We will point out some peculiarities by which the potato differs from other crops; for shortness sake we will confine ourselves to wheat, oats, beans, and turnips.

First, as regards the composition of the potato, we meet with the following differences:—

(a.) In the Organic Part.

The proportion of water. This is much larger in potatoes than either in beans, wheat, or oats, but smaller than in turnips. The consideration of this point must have particular influence on the method of storing.

The potato is rich in starch, whereas the turnip contains none; and it will be found, on eliminating the quantity of water in the calculation, that the first is not much inferior, as regards its pro-

* This analysis has been made by Mr Filgate whilst in Mr Johnston's laboratory.

portion of starch, to the richest corn crops. Besides pointing out the high value as an article of food, which this constituent gives to the potato, we would draw peculiar attention to the fact, that in the corn and leguminous plants the starch is contained in the parts above the ground, whereas in the potato this part has no starch at all, which on the contrary is accumulated in the subterranean part. In the turnip again, neither the one nor the other part contains any starch, which in the bulbous root (or rather dilated subterranean stem) appears to be chiefly replaced by sugar. The well-known property of starch—viz. that when exposed either to the action of dilute mineral acids, or even to that of water alone, at a certain temperature, it is successively converted into gum and sugar, may by the aid of future investigations suggest some new precautions both in the growth and storing of potatoes. We here abstain from such suggestions, because we think ourselves deficient in the necessary knowledge of co-operating circumstances, and we would therefore only draw attention to the well-ascertained fact, that the change effected in one constituent of an organic body is simultaneously communicated or transferred to the other constituents.

Further, the quantity of protein compounds in the potato, compared with that in beans, oats, and wheat, is small. And yet the whole amount of protein compounds, produced by an acre of potatoes, is much greater than that obtained from the same extent of land sown with any of the other crops This ought to be a very serious consideration in point of economical growing of food.

If we look to the inorganic part of the potato, we find that it differs from all the others by containing a very large proportion of potash, sometimes to the entire exclusion of soda. It is also richer in magnesia than in lime, in which respect the potato resembles wheat and oats, and probably also the other corn crops; but it differs from wheat, oats, and beans, as a whole plant, by containing only a small quantity of silica These peculiaritic refer to the kind of substances, which are chiefly carried off from the land by a crop of potatoes, and must therefore serve as a guidance with regard to the kind of manure that is best fitted to restore to the land what has thus been removed from it.

As regards the peculiarities in the structure of the potato, which may and probably will have material influence upon its growth or cultivation, we must remark, that we have here to do with a tuber, a subterranean stem, having every essential resemblance to an ordinary stem. The very unusual development of that part of it which corresponds to the bark of a tree, and, on the contrary, the almost total want of that part which in trees is so highly developed in the form of wood;—and further, its

compressed and irregular shape, causing the eyes or germs to be scattered almost in every direction over its surface, these are no doubt owing to the influence of the medium in which the potato grows, a moist mixture of inorganic and organic matter, of which the latter is in a continual state of decomposition, and, surrounding the tubers on all sides, causes an almost simultaneous development of all its parts.

We would further draw attention to the immense number of varieties of the potato, owing to climate and mode of cultivation. It is impossible to say what peculiar treatment these several varieties might require, in order to remain in health and vigour; that this treatment cannot and ought not to be the same *for all*, we have little doubt, at least if it is wished that they will all be equally able to bear up against unfavourable circumstances. In this respect, the physiology of the potato plant is yet a complete mystery.

The great productiveness and facility of cultivation of the potato, are properties which have done much to its being spread over such a large area of land. These peculiarities render it eminently fitted for becoming a staple food; both have undoubtedly had a great share in injurious abuses and neglects, which must necessarily have changed both its structure and composition.

The care and attention required in the storing of potatoes, and the damage attending any neglect on this head, are the natural consequences of the kind and condition of their constituents. The liability to freezing, by which this esculent is characterised, exhibiting itself by the production of a quantity of sugar, is likewise an effect of the properties of its component parts.

Considering all this, and we might have said a great deal more, it will be conceived that the liability of this plant to disease is not the least of its peculiarities. Whether we look at the variety, the extent or the early date of its diseases after it first came into cultivation, we will scarcely find any other plant similar to it in this respect. Former diseases, although partial, appeared nevertheless in different countries under the same or similar forms. It is true, however, that some of these forms were equally perceptible in plants of an entirely different class.

SECTION 4.—*Does the Ash of Diseased Potatoes differ from that of the Sound One?*

The small number of analyses of this kind that I have at present completed, does not as yet admit any positive conclusion. So far as I have gone, however, the decrease in the proportions of sulphuric acid and potash, and the increase in that of phos-

phoric acid in the diseased part is remarkable; although when compared with the entirely sound potato of the same kind, the quantity of the latter acid appears to have diminished also, a large quantity of alkaline carbonates having taken their place. In the one instance the chlorine seems to have almost entirely disappeared from the diseased part, in which, on the other hand, we perceive an increase in the silica.

This is all that I would here remark at present, and I confess these investigations are of too limited a nature to permit me to draw any conclusion from them, especially as the purposes served by these several ingredients are yet far from being clearly understood.

Section 5.—*Average Composition of the Ash of the Potato Tuber.*

Calculating this from the former tables we obtain the following result:—

	Calculated with carbonate acid.	Calculated without carbonic acid.
Potash,	43·18	52·40
Soda,	3·20	3 88
Lime,	1·80	2·20
Magnesia,	3·17	3·85
Oxide of iron,	0·44	0·53
Sulphuric acid,	15·24	18·50
Phosphoric acid,	8·61	10·45
Chlorine,	4·81	5·84
Silica,	1·94	2·35
Carbonic acid,	18·29	
	100·68	100·

The greater half of this ash, therefore, consists of potash. This appears to be a general result of every analysis, and in no other plant, to my knowledge, such a constancy in this ingredient exists.

Section 6.—*The relation existing between the Inorganic part of the Potato and the Soil and Manure employed.*

I shall here give the few analyses of soils that I have made, regretting that I have not as yet analysed the ashes of the potatoes that were grown upon them.

Soils No. 1 and 2 are from the same field, but No. 1 exhibits the composition of the soil at the commencement of the growth of the crop, (variety buffs, one with white and the other with red flowers,) and No. 2 after the crop had been removed. Common farm-yard dung was the only manure employed. No. 3 represents the composition of a soil upon which the crops were grown, frequently designated before by the addition, "from Mid-Lothian:"—

	No. 1.	No 2.	No. 3.
Organic matter, Fibres, &c.	8·64	7·74	8·72
Humic acid,	1·40	0·87	1·00
Alkaline salts, soluble in water, (potash, soda, chlorine, and sulphuric acid,)	0·06	0·02	0·37
Alkaline salts, soluble in acid,	0·45	0·30	
Sulphate of lime,	0·06	0·03	0·65
Oxides of iron,	4·17	4·25	5·65
Alumina, soluble in acids,	2·25	2·29	0·74
Carbonate of lime,	3·59	2·85	0·97
Carbonate of magnesia,	1·45	0·87	1·14
Phosphoric acid,	0·13	0·11	0·06
Soluble silica,	0·07	0·04	...
Insoluble siliceous matter, (silica, with silicates of alumina, lime, magnesia,)	79·34	79·60	81·55
	100·61	98·9	100·79

We perceive, in the first place, that there is a marked difference in the composition of No. 3, compared with the two others. It contains much less lime and alumina, and more of gypsum and oxide of iron; and yet, notwithstanding this, the crops grown upon these soils became both diseased. This soil seems to be deficient in lime; but it was analysed after the removal of the crop, and if we calculate by approximation how much lime one acre of this field may have contained—(supposing the soil to be four inches deep, one acre would contain about 640 tons of soil, that is 12,800 lbs. of carbonate of lime, which is many times more than the whole crop required)—then it would appear that this had no connexion with the disease. The magnesia, which appears to be so essential to the potato, is also present in sufficient quantity.

Between Nos. 1 and 2 there is a difference, which seems completely to be in accordance with what we might have expected. The phosphoric acid and the gypsum, the alkaline salts, the humic acid, and especially the magnesia and lime, have diminished. The small decrease in the three former ingredients over

such *a large surface* is fully equal to what was carried off by the crop.

I have been informed that the following varieties—of which the analyses are given above—had thus been treated:—

White Potato from Dumbartonshire.—"Forty tons farm-yard manure, with from forty to fifty barrels of lime, per Scotch acre, put on them when they were coming up. Part of the seed was dipped in sulphuric acid, but without any apparent effect."

Cups from Argyleshire, (sound and diseased.)—"Planted in the spring of 1845, with horse and cow-dung mixed. The land had been previously trenched to the depth of two feet. In the harvest of 1845, after the shaws were withered, they were covered over from the drills with a spade, and remained so until sent for analysis."

Red Potato from Ayrshire.—"Was grown on very stiff clay land. It had been trenched in winter, and thoroughly drained. The field is much surrounded by wood, and had never grown potatoes before."

Section 7.—*What inorganic substances a Potato Manure ought to contain, and in what proportions?*

It will not be very difficult to answer this question; for, knowing the average composition of the ash of sound potatoes—(the differences between the several varieties will be of little consequence)—and proceeding upon the principle, that in manuring a crop we do nothing more than mix up with the soil different proportions of those substances of which the crop itself consists, we need only to re-calculate the table presenting this composition in a hundred parts. In how far the excess of one ingredient will do harm when all the others are present in sufficient quantity, it is almost impossible to say, although it cannot certainly be great; but when there is a deficiency of any ingredient, potash for instance, and an excess of another, such as lime, then it is likely that the plant will assimilate the latter instead of the former, or rather, the acids that are in the plant requiring to be neutralized, will combine with lime in such proportion as there is a want of potash. It may be that the quantities of these inorganic ingredients appear trifling, considering that of them altogether there is only about one per cent present in potatoes, and therefore of little consequence; yet there are reasons to think that these small quantities, and their exact proportions, within certain limits, are of essential importance for the proper performance of the functions of the several organs of the plant.

It would seem to follow, from this reasoning, that the manure and the soil might have really had considerable influence upon the present disease; but, although admitting this with regard to

other local diseases, I am by no means disposed to do so as regards the present one, on account of its remarkable universality in the most different soils, regions, and climates, and under the most different treatment; and I would rather be inclined to believe that the *predisposition* to this disease was the effect of previously accumulated changes in the plant itself.

The substances that ought to be present in a potato manure are the following, arranged according to their *several proportions:*

BASES,	ACIDS,
Potash,	Sulphuric acid,
Magnesia,	Phosphoric acid,
Soda,	Chlorine.
Lime.	

Oxide of iron and silica are present in every soil, and the organic acids are produced within the plant itself. The proportions are the following per ton:—

Potash, . .	1180 lbs.
Magnesia, . .	87
Soda, . .	87
Lime, . .	50
Sulphuric acid,	416
Phosphoric acid.	235
Chlorine,	195

PART II.—ON THE COMPOSITION OF THE POTATO TOP.

I.—COMPOSITION OF THE FULL GROWN POTATO TOP.

SECTION 1.—*Proportion of Water, of Organic and Inorganic Matter in the Potato Top.*

(a.) In the Stem.			*(b.) In the Leaves.*		
		Calc. Dry.			Calc. Dry
Water,...........	89·73		Water,...........	85·22	
Organic Matter,	8·49	82·67	Organic Matter,	12·51	84·55
Inorg. Matter,...	1·78	17·33	Inorg. Matter,...	2 27	15·45
	100·	100·		100·	100·

On comparing these two results, we perceive that the stems contain on an average 4½ per cent more of water, and seemingly

½ per cent less of inorganic matter; but the latter relation is owing to the former, for when calculating both in the dry state, the proportion of inorganic matter in the stem exceeds that in the leaves by about 2 per cent.

If we consider what one of the chief functions of the leaves is, namely, the evaporation of moisture, we need not be surprised that these thin membranaceous organs should contain less water than the thick and tubular stems; the latter serving at the same time to convey the inorganic matter from the soil to the leaves, and receiving back from the latter whatever is separated in consequence of the endosmotical actions of their cells. There is thus in the stem a double source from which they may derive their inorganic constituents, and thus the large proportions of these may be accounted for.

(c.) *In different Varieties.*

	T. White Buffs. From the same Field.		Red Buffs. From the same Field.		Cups. F.	Cups. C.
	Stems.	Leaves.	Stems.	Leaves.	Stems.	Leaves.
Water, ...	91·51	84·99	88·65	84·29	92·59	86·47
Inorganic matter,...	1·67	2·39	1·52	2·48	1·66	2·09
Organic matter, ...	6·82	12·62	9·83	13·23	5·75	11·44
Do., Calc. dry:						
Inorganic matter,...	19·65	16·06	12·65	15·85	22·43	14·55
Organic matter, ...	80·35	83·94	87·35	84·15	77·57	85·45

These two varieties of buffs were grown upon the same field, (of which the composition has been given before,) and gathered at the very same time. The difference between the proportions of ash and water in both varieties is remarkable. In the stems of the white buffs there is about three per cent more of water, and although in the wet state they only contain 0·15 per cent more of inorganic matter, yet the difference in the water has the effect of increasing that of the inorganic matter to seven per cent, which is a little more than two-thirds of the red variety.

Certainly, with such facts, we can scarcely entertain any doubt as to the existence of constitutional differences, even in varieties between which there is little external difference. When looking at the leaves, we find the two results almost identical; for the inverse ratio between the proportions of water and inorganic matter in the two varieties, makes the latter, when calculated in the dry state, approach so nearly to the other, that we

may almost call them identical. The leaves being so very much influenced by external circumstances, we might expect that those of these two varieties, placed in the same atmosphere, over an extent of a limited number of acres, will lose by evaporation about the same quantity of water in a given time; and this being the case, then a liquid of nearly the same density will be left behind, if this density was the same before the evaporation. The difference, however, in the proportions of water and inorganic matter in the several stems, shows that this was likely not the case, that in the white variety being more saturated with salts than that in the other. If, therefore, the leaves of the white variety lost the same quantity of water by evaporation as those of the red, then a denser liquid will have been left behind. A larger quantity of solid matter, therefore, must have returned from the leaves of the white variety, causing them to retain about the same proportion of inorganic matter as those of the other; and thus it is that the stems may have derived their large proportion of inorganic matter, not merely from the soil, but also from the action of the leaves.

The cup variety appears to contain less inorganic matter, and more water in the leaves, than the former. As to the stems, they contain still more of these substances than the stems of the white buffs.

Section 2.—*Composition of the Ash of Potato Tops.*

(*a.*) *From different Potatoes.*

	T. White Buffs.		Red Buffs.	
	Stems.	Leaves	Stems.	Leaves.
Potash,	31·15	17·27	35·32	18·63
Soda,	5·80	...	3·78	4·58
Chloride of potassium,	...	4·98	...	19·72
Do. do. sodium,	21·60	14·85	21·03	2·39
Lime,	19·13	26·98	20·24	26·09
Magnesia,	5 09	6·04	4·39	4·59
Oxide of iron,	1·43	3·70	1·34	3·50
Sulphuric acid,	5·56	5·76	6·02	7·99
Phosphoric acid,	6·90	14·94	5·51	9·29
Silica,	3·34	5·48	2·37	3 22
	100·	100 00·	100·	100·

(*b.*) *Grown on different Soils.*

I can only give one instance, which may be compared with the two former. The analyses of the soils are given before; this variety was grown on soil No. 3.

	Cups.	
	F. Stems.	C. Leaves.
Potash....................	34·02	23·29
Chloride of potassium,....	23·65	4·08
Do. do. sodium,........	1·85	12·71
Lime,......................	17·96	25·81
Magnesia,.................	5·89	9·71
Oxide of iron,.............	0·53	1·46
Sulphuric acid,............	6·09	11·74
Phosphoric acid,...........	8·32	9·43
Silica,.....................	1·69	1·77
	100·	100·

The remarks that may be made upon these results, are as limited as the latter are in number. On the whole, there appears to have been more potash, magnesia, and sulphuric acid, and less soda, silica, and oxide of iron in the cups than in the buffs, the phosphoric acid, lime, and chlorine, having remained very much the same. Between the two buff varieties we perceive a great difference in the phosphoric acid, also a considerable one in the potash; the other ingredients having not been materially altered.

SECTION 3.—*Relative Composition of the Ash of the Stem and Leaves.*

With regard to this point, I can state,

1st, That the stem contains a greater quantity of alkalis than the leaf.

2d, That the leaf contains more lime and phosphoric acid than the stem.

3d, That the quantity of oxide of iron is greater in the leaf than in the stem; and also, in two instances, that of magnesia.

Among these differences, that of the phosphoric acid is one of the most important, especially when viewed in connexion with the protein compounds, with which the phosphoric acid, in combination with lime and magnesia, is so intimately connected. I think I have found, by a great number of analyses, that the relation between the quantities of phosphoric acid in the stem and leaf is not much different from that of the nitrogen, which these two parts severally contain.

SECTION 4.—*Value of the Tops as a Manure.*

This value is at once apparent, if we look at the large quantity of valuable ingredients which the tops contain, and which, if they are left upon the land and ploughed in, are restored to the soil in a condition in which they can act most beneficially.

This value becomes still greater, from the large quantity of various nitrogenous compounds which the tops contain, and which assist directly in the formation of new nitrogenous ingredients. I have ascertained that the average proportion of nitrogen in the leaf is as follows:—

100 lbs. of leaves in the natural state,
contain from 0·82 to 0.92 lbs of nitrogen;
or 100 do. of dry leaves, . 5·12 to 5·76 do. do.

By every ton of potato tops, therefore, we add to the land about 50 lbs. of inorganic salts, and a quantity of organic matter, containing 20 lbs. of nitrogen, or about 23 lbs. of ammonia; this being, probably, the form under which the nitrogen is gradually discharged in the decomposition of organic matter. The best Ichaboe guano does not yield more than 9 or 10 per cent of ammonia, and therefore 1 ton of potato tops may in this respect be compared with 2¼ cwt. of the latter.

II.—COMPOSITION OF THE POTATO TOP, AT DIFFERENT PERIODS OF ITS GROWTH.

SECTION 1.—*Water and Ash in the Top at different stages of its growth.*

(*a.*) *The Young Shoot.*

	1. From a Buff Potato taken from a pit.	2. From a White Potato from Dumbartonshire.	3. From Canadians.	4. From Buffs from Forfarshire.	5. From Potatoes from Orkney.	6. From White Potatoes from East-Lothian. March 6.	7. April 6.	8. May 7.	9. June 8.
Ash per cent,	0.76	1·26	1·40	1·70	1·61	1·40	1·63	2·39	3·10
Do. calculated dry, . . .	11·62	10 96	10·77	8·83	8·77	10·37	11·04	17·77	17·22

The large proportion of inorganic matter in the shoots, is in accordance with what we might expect. It is curious to observe (6, 7, 8, and 9,) how this proportion increases with the period of their growth. The tuber must become exhausted in the same ratio.

(b.) At Successive Stages.

RED BUFFS FROM MID-LOTHIAN.

	Leaves.							
	30th May.	13th June.	27th June.	11th July.	21st July.	8th Aug.	15th Aug.	22d Aug.
Water per cent, .	89 76	87·22	84·12	84 80	81·79	81·37	82·80	82 44
Ash, ...	1·44	2·68	2.33	1·98	2·73	2 95	3·21	2 55
Do. calculated dry,	14 06	20 97	14 67	13·03	15·00	15·86	18·66	14.52

	Stems.														
	13th June.		27th June.	11th July.		25th July.		8th Aug.		15th Aug.		22d Aug.		29th Aug.	
	top.	bot.		top.	bot.	top.	bot.	top.	bot.	top.	bot.	top	bot.	top.	bot.
Water p. cent,	92·37	86·40	91·30	94·00	88 21	89.78	88·44	87·89	83·71	90·54	87·38	89·65	87·53	79·23	69·81
Ash, . . .	2·18	1.95	1·89	1·45	1·88	1·70	1 78	1·47	1·38	1·46	1·48	1·50	1·75	4·03	2·46
Do. calc. dry,	28·57	14·34	21·72	24.17	15·93	16.67	15 40	12.25	8 47	15·43	11·75	14 50	14·03	19 40	8·14

On the 29th of August nearly all the leaves had fallen off, and the few that remained were entirely blackened and dry.

The decrease of the water in the leaves does not seem to have caused any decrease in the inorganic matter during the different periods. In the stems, we see a very regular diminution of water, which is always least in the bottom part. The inorganic matter in the two halves of the stem seems to follow nearly the same course—as if the upper part received an additional supply from the leaves, which did not return to the bottom part.

(c.) Different Varieties, and from different Soils.

T. WHITE BUFFS FROM THE SAME FIELD.

	Leaves.				
	30th May.	13th June.	27th June.	11th July.	25th July.
Water per cent, .	85·57	85·19	84·33	86·38	83·50
Ash, ...	2·35	2·54	2·31	2·22	2 54
Do. calculated dry,	16 28	17·15	15·24	16·30	15·39

	Stems.			
	13th June.	27th June.	11th July.	25th July.
Water per cent, . .	94·04	93 20	91·54	86·73
Ash, ...	1·75	1·63	1·71	0·89
Do. calculated dry, .	29·34	23·60	20·21	14·04

Cups from Mid-Lothian.

C.	Leaves.									
	5th June.	12th June.	19th June.	26th June.	3d July.	10th July	17th July.	24th July.	31st July.	7th Aug.
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Water per cent, . .	89·29	87·07	86.69	84 81	84·31	5·99	87.13	85 33	84 67	83 93
Ash per cent, . .	1.63	2·34	2·31	1·95	1·71	1·92	1·76	1·70	1 77	2·21
Do. calculated dry, .	15.23	18.14	17·37	12·83	10·90	13·71	13·68	14 57	11·54	13 75

F.	Stems.									
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Water per cent, . .	94·38	94·36	92·21	92 28	92·05	92·08	92·22	95·38	90·25	90·70
Ash, ...	1·60	1·63	1·86	1·75	1·79	1·66	1·65	1·38	1·59	1·73
Do. calculated dry, .	28·47	28·90	23·87	22·73	22·51	20·96	21·21	29·90	16·31	18·60

The variations in the proportions of ash and water in the stem, are greater in the buffs than in the cups. The decrease of ash in the stem of the buffs is also greater than in the other variety, in which it seems to follow an almost regular course. The leaves become drier as the period advances; but the proportion of inorganic matter which they contain does not appear to be much altered. Here and there we perceive a rapid variation, but the former proportion is equally quickly restored. They seem, therefore, to have lost this water merely by an excess of evaporation, compared to the supply conveyed through the stem; that is, the mechanical influence of the atmosphere upon the leaves went on uninterrupted, whilst the absorbing power (and perhaps also the moisture in the soil itself) had decreased. But the quantity of inorganic matter, being a requisite for the existence of the leaves, remained nearly the same till the last.

SECTION 2.—*Composition of the Ash of the Growing Crop.*

(*a.*) *At Successive Stages.*

RED BUFFS FROM MID-LOTHIAN.

TABLE 1.—LEAVES.

	30th May. (Leaves and Stalks.)	13th June.	27th June.	11th July.	25th July.
Potash,	15·59	8·43	24·12	11·80	13·20
Soda,	9·19	9·50	5·49	...	...
Chloride of potassium,	30·27	15·69	23·10	16·29	18·27
... sodium,	...	12·04	...	...	...
Lime,	15·03	28·88	18 59	38·27	36·70
Magnesia,	2·63	2·98	2·32	7·08	8·32
Oxide of iron,	2·57	2·64	5·10	4·20	3·20
Sulphuric acid,	10·42	7·15	6·40	9·23	9·07
Phosphoric acid,	12·04	6·25	10·58	10·84	9·24
Silica,	2·26	6·45	4·30	1·39	2·00
	100.	100.	100.	100.	100.

TABLE 2.—STEMS.

	13th June.	27th June.	11th July.
Potash,	7·41	19·44	30·03
Soda,	17·43	20·03	...
Chloride of potassium,	29·98	28·00	24·52
Lime,	24·84	13·64	24·02
Magnesia,	5·99	2 64	4·91
Oxide of iron,	1·54	1·99	0 64
Sulphuric acid,	6.32	5·55	6·73
Phosphoric acid,	4·57	6·50	5·94
Silica,	1·92	2·21	3·21
	100.	100.	100.

In these and the following analyses I have not taken into account the carbonic acid—this being merely a product of combustion of the organic acids; but subtracting its per centage from that of the sum-total, I divided each individual ingredient by this redúced divisor. We thus retain the true mutual relation between the several inorganic constituents.

(b) *Of different Varieties, and from different Soils.*

WHITE BUTES FROM MID-LOTHIAN.

T.	TABLE 3.—LEAVES.				
	30th May. (Leaves and Stalks.)	13th June.	27th June.	11th July.	25th July.
Potash, . . .	22 45	15·38	14·79	16·69	17·27
Soda, . . .	17·51	...	...	0·95	...
Chloride of potassium,	...	12 13	12·66	...	4·95
... sodium, .	19·41	11·45	9·18	21·66	11·37
Lime, . . .	13·11	22·25	32·08	25·92	27·69
Magnesia, . .	5·54	5·16	5·26	5·97	7·78
Oxide of iron, . .	2·50	4·01	2·91	3·37	4·50
Sulphuric acid, .	1·63	6·80	4.35	5·53	6·37
Phosphoric acid, .	14·97	17·74	14·42	14·01	13·60
Silica, . . .	2·88	5·40	4·35	5·90	6·47

100.

T.	TABLE 4.—STEMS			
	13th June	27th June	11th July.	25th July.
Potash, . . .	19·85	31·52	32·63	39·53
Soda, . . .	7·97	...	11·41	3·95
Chloride of potassium,	...	0·91	...	...
... sodium, .	21·73	20·70	22·99	20·43
Lime, . . .	23·23	25·03	13·42	14·85
Magnesia, . .	6·74	5·86	3·68	4·10
Oxide of iron, . .	2 38	0·89	1·11	1·34
Sulphuric acid, .	5·17	5·44	5·08	6 56
Phosphoric acid, .	6·97	7·00	6·97	6·68
Silica, . . .	5·46	2·65	2·71	2·56

100.

CUPS FROM MID-LOTHIAN.

C.	TABLE 5.—LEAVES.							
	June 19.	June 26	July 3	July 10.	July 17.	July 24.	July 31.	Aug. 7.
Potash, . . .	11·55	10 39	27 46	27 32	27·30	28·74	20·31	25·03
Soda, . . .	...	...	5·17	2·13	1·36	1·98	...	...
Chloride of potassium,	11·92	11·66	...	...	...	...	9·88	5 67
... sodium, .	7·31	5·20	16·80	15·00	10 75	15·16	6·00	9 86
Lime, . . .	29·24	37·32	19·19	19·11	26 35	18·12	23·38	27·59
Magnesia, . .	8·40	10·78	6·95	11·08	11·13	9·29	11·75	11·25
Oxide of iron, . .	1·24	2·88	1·80	1·65	0 70	0·54	0·66	0·63
Sulphuric acid, .	7·86	6·23	6 46	10·93	11·05	12·30	12·69	11·77
Phosphoric acid, .	9 31	12·70	13·23	9·18	10·61	12 92	14·38	7·33
Silica, . . .	3·17	2·84	2·94	3·60	0 75	0·95	0·95	0·87

100.

CUPS FROM MID-LOTHIAN—*Continued.*

F.	Table 6.—Stems.				
	June 19.	June 26.	July 3.	July 10.	July 17.
Potash, . . .	35 60	30·35	36·20	39 17	32·55
Chloride of potassium,	17·28	19·30	29·39	26·74	28.27
... sodium, .	2·88	2·40	1·78	1·46	0·76
Lime, . . .	20·76	26·07	10 99	12·05	11 87
Magnesia, . .	6 38	8 03	4·76	5·25	5·43
Oxide of iron, . .	0·32	1·22	0 48	0·41	0·47
Sulphuric acid, .	6·62	3·44	5·48	4·61	8·37
Phosphoric acid, .	8·65	7·00	8·62	8·72	10·65
Silica, . . .	1·51	2·19	2·30	1·59	1·43

100·

On looking at these tables, we find the following peculiarities:—

Table 1st. 13th to 27th of June. Alkalies unaltered, lime greatly and magnesia slightly diminished, phosphoric acid increased, chlorine, sulphuric acid, and silica, decreased, oxide of iron increased.

In the two subsequent periods the alkalies decreased, the lime is doubled, the magnesia tripled, phosphoric acid unaltered in the first and decreased in the second, chlorine unaltered, sulphuric acid increased, silica much, and oxide of iron less decreased.

In the 2nd table we perceive the following:—

The two first periods. Alkalies increased, lime and magnesia decreased, phosphoric acid increased, chlorine unaltered, sulphuric acid a little diminished, silica and oxide of iron a little increased.

Third period. Alkalies again decreased, lime and magnesia increased to their former amount, phosphoric acid unaltered, chlorine and oxide of iron decreased, sulphuric acid and silica increased. With regard to this silica I must remark, that it was all in the soluble form.

Summing up all this, and comparing the stem with the leaves, we find in general, that the alkalies prevail in the stem; but that the leaves contain a larger proportion of lime, magnesia, and phosphoric acid; the differences in the other ingredients, which are themselves perhaps of less importance, being smaller.

With regard to the successive proportions of these constituents in the plant, taken as a whole, it would appear, that at the two first periods the stems were conveying chiefly alkalies and phos-

phoric acid to the leaves; but that, perhaps in consequence of this, the lime and magnesia diminished in quantity.

The next period the alkalies decreased again, especially in the leaves, but the lime and magnesia are again greatly increased, chiefly in the leaves. The quantity of phosphoric acid is not much affected.

Similar remarks may be made upon the two other sets of tables, of which their summary may be represented as follows:—

Tables 3 and 4. The alkalies prevail in the stem, more so than in the former variety; the leaves contain more lime and phosphoric acid than the stem; the quantity of magnesia is nearly equal in both at first, but afterwards it increases in the leaves, and diminishes in the stem.

As the proportion of alkalies in the leaves is, in this instance, the same through the four periods, but that in the stems increasing until the third, when it remains unaltered, it would appear that, although the stems have also in this instance conveyed alkalies into the leaves from the beginning; yet the quantity returned to the stems from the leaves was equal to that which had ascended into the latter, whilst at the third period there was an additional quantity extracted from the soil. The same applies, to a certain extent, to the lime and magnesia; but in consequence of the increase of alkaline matter in the stems, the quantity of these earthy bases diminishes. The conveyance of phosphoric acid to the leaves continues almost uninterrupted; but in the latter periods they seem to have lost more than they received. Perhaps the stems themselves extracted less from the soil, and thus the unaltered quantity of it in the stem may have arisen from an increased descent of this acid from the leaves.

Tables 5 and 6. The alkalies prevail in the stem; but whereas, in the first variety, (table 1st,) the quantity of these substances in the leaves diminished, and remained constant in the second, (table 3d,) they here increase almost to the double; in the stem, they here approach more to stability, which seems to imply, that less returned from the leaves than in the two other specimens; supposing that, through all the periods, the stems extracted about the same quantity from the soil, which is likely in this case, from the accumulation that took place in the leaves. Of phosphoric acid, lime and magnesia, again, we find throughout a greater quantity in the leaves than in the stems. The two earthy bases frequently change place with the alkalies, by a mere chemical action, and the leaves seem to have always returned less phosphoric acid than they received. It is, however, remarkable, that at the last period the quantity of this acid in the leaves is so much diminished; as the disease commenced about this latter period. I also found a very considerable dimi-

nution of nitrogen in the leaves of the same date, which appears to confirm what I have stated before, as to the close connexion between the two latter constituents in living bodies.

Having now finished my paper, of the imperfections of which I am fully sensible, it will naturally be expected that I shall draw some conclusions, derived from the results of my investigations. Although doubtful and hesitating at first, I have been frequently inclined to hazard some opinion. But each time I felt my inability to draw positive conclusions from such a limited number of results. The disease has prevailed throughout a large portion of the world, and it would almost require an exact knowledge of every possible circumstance under which the numerous varieties in different places have been grown, to come to any thing like a sound conclusion.

I am, however, satisfied, that there are actual differences existing between different varieties, which may have had some influence in rendering them unequally liable to disease; for I consider it as highly probable that every alteration in the nature and properties of a plant, must arise from differences in the functions of its several organs, attended by differences in its composition. It is clear that external circumstances *may* be the primary causes of such differences; but these causes will influence the functions of a plant, and by these functions its properties are determined.

But differences seem likewise to exist between various specimens, although belonging to the same variety, and these are likely to be effected by different treatments in different regions and climates. In how far the latter circumstances were co-operative in developing, what I call a predisposition of the plant to disease—a predisposition which may possibly have gradually arisen from similar causes, viz., treatment, &c.—I am not as yet prepared to pronounce.

Suffice it to say, that it results from the above investigations:

1st, That there are essential differences in the organic and inorganic constituents of different varieties.

2d, That there is a difference in the proportion of water contained in sound and diseased potatoes. That the latter may contain more whilst they are still in the soil, but that they are subject to a more rapid exsiccation.

3d, That the quantity of water is more unequally divided through a diseased, than through a sound potato; the differences in this respect, between the two extremities, being more considerable in diseased specimens.

4th, That, however, this difference seems to be a general rule in all kinds of potatoes—leaving it undecided in how far this was an effect of cultivation.

5th, That the same remarks apply, to a great extent, also to the inorganic constituents of sound and diseased potatoes.

6th, That there is a difference between the properties and kind of the protein compounds that exist in sound and diseased potatoes. The positive nature of these alterations, however, and their connexion with the diseased state of a potato, I have not yet sufficient evidence to explain.

7th, That there are differences in the quantities of the protein compounds, as contained in sound and diseased potatoes. There seems to be a diminution of nitrogen in the diseased tops, or at least the proportion of nitrogen diminished in the tops when they became diseased; whilst, on the other hand, there was an increase of nitrogen in diseased tubers, which however may, in successive stages, be converted into a decrease, on account of a disengagement of ammonia, arising from the decomposition of the protein compounds.

With regard to the question, if high manuring could have caused or aggravated the disease, I must delay to answer. The aggravation of the disease by these means appears to me not unlikely, on the ground, that, as I believe, every natural family of plants contains, within certain limits, a definite proportion of both organic and inorganic constituents, which it cannot exceed to any considerable extent, without becoming more liable to be affected by external circumstances.

It is only by judicious perseverance that we may hope gradually to become better acquainted with the still mysterious character of the highly interesting and useful potato; but without *labour* no results can be obtained; and, without perseverance, every labour undertaken is of little avail.

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EDINBURGH: BALLANTYNE AND HUGHES.

PREMIUMS

OFFERED BY

THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND,

IN

1846.

CONTENTS.

PRELIMINARY NOTICE.

The business of The Highland and Agricultural Society of Scotland is conducted by a President, Four Vice-Presidents, Thirty Ordinary, and Ten Extraordinary Directors, a Treasurer, an Honorary Secretary, and a Secretary, to the latter of whom all communications are addressed. The Ordinary Directors are subdivided into Committees for the dispatch of business, assisted occasionally by those Ordinary Members most conversant with the subjects to be considered, or with the duties to be discharged. The report of each Committee is brought before the Directors collectively for farther procedure, and their proceedings are again submitted for approbation to a half-yearly General Meeting of the Society. One of the General Meetings is, by the Charter, appointed to be held on the second Tuesday of January; the other on such day in the months of June or July as the Directors may fix. New Members are admitted at either of these General Meetings by ballot. They pay a small annual contribution of L.1, 3s. 6d., or, at their option, and in full of all future claims, a life subscription of Twelve Guineas. The Annual Subscription is payable in advance, and must be remitted, without expense to the Society. All Meetings of Directors, or Committees, are open; and at these any Member may attend and deliver his opinion on the subjects under consideration, though, in cases of division, the Directors or Members of the Committees only are entitled to vote.

When the Highland and Agricultural Society of Scotland was instituted in the year 1784, the object chiefly contemplated was the improvement of the Highlands, and hence the name—The Highland Society of Scotland—which it then assumed. But the great increase in the number of its Members since that time, the happy management of its funds, and the change in the general state of the country, have long enabled it to extend the design of its first institution, and direct attention to every part of North Britain where industry might be excited or the useful arts improved. In accordance with this extension of the purposes of its institution, the Society, in its Supplementary Charter, has been named The Highland and Agricultural Society of Scotland.

The Society has, neither by its Charters of Incorporation, nor by its practice, been limited in its patronage to any one department of Industry; but it has regarded as the fitting objects of encouragement, every application of useful labour which might tend to the general good. But, although its patronage be thus extended as regards its objects, circumstances have arisen to modify, in some cases, the application of it. The establishment of certain Boards, for the encouragement of the Herring Fishery, and the like, has induced the Society to restrict its original views, and to devote its attention, and apply its funds, in a more special manner, to other objects, and chiefly to Agricultural and Rural Economy in their various branches.

In fulfilment of its purposes, the Society is every year accustomed to offer and award a variety of Premiums, as the means of eliciting and diffusing knowledge, as incitements to industry, or as the rewards for useful undertakings. These relate to every subject which may be supposed to fall within the plan of the Institution:—such are,

the Improvement of Waste Lands by Tillage, by Irrigation, or by Draining, the development of the Mineral Products of the country, the Extension of Plantations, as the objects of ultimate profit, or of present embellishment and shelter,—the improvement of the breeds of Live Stock, and, not the least in interest and importance, the awakening the industry of the Lower Ranks to pursuits calculated to promote their content, by ameliorating their condition. A Mechanical Department exists for rewarding the original invention or subsequent improvement of all machines and implements for Agricultural purposes, the construction of those for other branches of Rural Economy, and of some for domestic convenience. Models of these are received and preserved in the Society's Museum; and descriptions of all such as merit attention are as speedily as possible conveyed to the public.

Although certain subjects be thus selected as the objects of experiment or discussion, the patronage of the Society is not restricted to these objects. Its purposes being the promotion of general industry and improvement, it receives with favour every communication and statement of facts which may admit of an useful application.

The papers of the Society are printed periodically in "THE JOURNAL OF AGRICULTURE, AND THE TRANSACTIONS OF THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND," published by Messrs. BLACKWOOD, 45, George Street, Edinburgh, and 37, Paternoster-Row, London.

The Society is prepared to receive with attention all written communications, in the form of Essays, Reports, Notices of Experiments, and the like, which may be presented to it by LOCAL ASSOCIATIONS. Such communications, if approved of by the Society, will be inserted in the Transactions; and opportunity will be given to the Authors or Associations of obtaining separate copies from the types for circulation in their Districts.

All communications relating to Premiums, as well as Papers or Reports for publication in the Transactions of the Society, and other subjects for the consideration of the Directors, are to be addressed to JOHN HALL MAXWELL, Esq., the Secretary of the Society, at the Society's Hall, Albyn Place, Edinburgh.

NOTICE TO CANDIDATES,

AND GENERAL RULES FOR COMPETITION.

When subjects are specially selected for competition, it is always to be understood, 1st, That however concisely the subjects themselves be announced, ample information is required concerning them—2d, That this information shall be founded on experience or observation, and not on simple references and quotations from books—3d, That it shall be digested as methodically as possible—and, 4th, That Drawings, Specimens, or Models, adapted to a defined scale (3 inches to the foot, if convenient) shall accompany writings requiring them for illustration.

Certain conditions are annexed to each of the various subjects of competition, as detailed in the List of Premiums; and these are rigidly enforced by the Society, as the only means of insuring regularity in the conduct of the business, and of distributing exact justice among the Competitors.

In all Essays for Competition for Premiums offered, it is expected that when facts not generally known are stated, they will be authenticated by proper references. Competitors in Essays and Reports are required to quote, or state distinctly on the top of the first page of their paper, the *number* and *title* of the subject or Premium for which they compete. They must not communicate their names, but transmit, along with the Essays, a sealed note, containing their names and addresses, and inscribed on the back with some distinguishing motto or device, which shall also be inscribed on the

Essay. When this regulation is neglected, such Essay shall not be received in competition. If the Essayist has formerly gained a Premium from the Society for a Paper communicated by him, it is recommended, that his subsequent Essay should be written in a different hand from that of the former successful Paper. All communications designed for Competition must be written in a distinct and legible hand.

None of the sealed notes, except those that bear the distinguishing motto or device of the Essays found entitled to Premiums will be opened; and the sealed note will not, in any instance, be opened, without the consent of the author, unless a sum equal to, at least, one-half of the Premium offered shall have been adjudged. But should no application be made for the paper on or before the 1st of March in each year, it will be held as belonging to the Society. Such Essays as are not found entitled to any Premium will, with the sealed notes, be returned to the authors if required. The Society is to be at liberty to publish the Essays, or extracts from them, for which the Premium, or part of it, shall be awarded.

Candidates are requested to observe, that, in any instance, when Essays, Reports, or Certificates, are unsatisfactory, the Society is not bound to give the reward offered; and that, in certain cases, power is reserved of giving such part only of a Premium as the claim may be adjudged to deserve; but Competitors may feel assured, that the Directors will always be inclined to judge liberally of their several claims.

Essays, Reports, or Communications, on subjects for which Premiums have in former years been offered, will still be received, although the subjects may now be discontinued on the List, and Honorary awards will be voted, when the communications appear to merit them.

Essays and Reports, for which no Premiums have been awarded, must, if desired to be returned, be called for within one year from the date of Competition, otherwise the Society will not be responsible for the papers.

Competitors will understand it as a condition having reference to every Premium and Reward offered by the Society, that the decisions of its Committees and Board of Directors, as confirmed by the Society, are to be final and conclusive, and that it shall not be competent to raise any question or appeal touching such decisions before any other tribunal.

In Reports of Experiments relating to the Improvement or Management of Land, it is expected that the expenses shall be accurately detailed.

In all Premiums offered, having reference to Weight or Measure, the New or Imperial Standards are alone to be understood as referred to; and Competitors are required to state their calculations according to these, the only legal standards, otherwise the claim will not be entertained.

When the Premiums are awarded in Medals or Plate, the Society will, in such cases as the Directors may see proper, allow them to be paid in money, on the application of the successful Candidates.

The Premiums awarded by the Society, are payable after the 10th February, for the preceding year. Orders payable at the Royal Bank of Scotland, are issued of that date, by the Directors, in name of the parties in whose favour the Premiums have been awarded. The orders will be delivered at the Society's Hall, upon the receipts of the parties to whom the Premiums have been adjudged being presented; or the parties may transmit, through any Bank, stamped receipts, or negotiate bills, addressed to the Treasurer or Secretary, if done without expense to the Society. The receipt or bill must specify distinctly the Premium in discharge of which it is sent.

Parties entitled to *Plate* or *Medals*, will, by themselves, or some person having their authority, apply at the Society's Hall, for an order on the Society's Jeweller or Medallist.

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ROBERT G. BAILLIE, Esq. of Coulterallers.
DAVID LOW, Esq. of Laws, Professor of Agriculture in the University of Edinburgh.

CHAIRMEN OF STANDING COMMITTEES, 1846.

Funds and Accounts, . . .	GEORGE TURNBULL, Esq. of Abbey St. Bathans.
Publications and Papers, . .	Professor TRAILL.
Mechanics, ...	Sir JOHN GRAHAM DALYELL of Binns, Bart.
Geology and Chemistry, . . .	DAVID MILNE, Esq. of Milnegraden.
Cottages, ...	R. G. BAILLIE, Esq. of Coulterallers.
The Veterinary College, . . .	JOHN BURN MURDOCH, Esq. of Gartincaber.
Regulations for Shows of Live Stock, ...	WILLIAM SCOT, Esq. of Craigmuie.
The Argyll Naval Fund, . .	ALEXANDER LAMONT, Esq. of Knockdow.

THE SOCIETY'S MUSEUM, GEORGE IV. BRIDGE.

The Right Honourable LORD BERRIEDALE,
Chairman of the Committee of Superintendence.

CHARLES LAWSON, *Conservator.* MR GEORGE W. YOUNG, *Assistant.*
MR JAMES SLIGHT, *Curator of Models.*

CHAIRMEN OF MONTHLY MEETINGS,

HELD AT THE MUSEUM.

Chairman.—The Right Hon. the EARL of ROSEBERY, K.T.
Deputy-Chairmen.—Sir JOHN STEWART RICHARDSON of Pitfour Bart.; JAMES CAMPBELL, Esq. of Craigie; DAVID MILNE, Esq. of Milnegraden; and Sir GRAHAM G. MONTGOMERY of Stanhope, Bart.

PREMIUMS.

SOCIETY'S HALL, ALBYN PLACE,
EDINBURGH, 10*th February*, 1846.

THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND offers the following PREMIUMS for Competition in 1846, and following years:—

CLASS A.

ESSAYS AND REPORTS.

§ I. ON SUBJECTS CONNECTED WITH THE SCIENCE AND PRACTICE OF AGRICULTURE.

1. EXPERIMENTS IN DEEP PLOUGHING.

For an approved Report of experiments made to ascertain the results of subsoil ploughing, Trench ploughing, or any other mode of deep ploughing on thorough drained land, or on land that does not require draining, with the comparative merits of the different modes on the same soil—The Gold Medal.

The experiments must be made on not less than four acres of land, of, as nearly as possible, the same soil and description, and the Report must state the description of soil, and the subsoil upon which it rests, in each of the methods of ploughing, one-half of which shall have been deep ploughed, and the other half cultivated in the ordinary way. The whole extent of ground to be under the same description of crop, and in other respects both portions to be cultivated and managed alike. The quantity and quality of the produce of each portion to be stated; the depth reached by the plough to be noticed, with such other observations as the experimenters may deem deserving of attention.

Besides the principal Premium for the year, the Society proposes to give Honorary Premiums for such reports as shall be deserving of distinction.

Reports to be lodged by 10th of November, in any year.

2. SPADE AND FORK HUSBANDRY.

The process of delving and subsoiling, by the joint operation of the spade and fork, having attracted considerable attention in the experimental field for the trial of implements, in connexion with the General Show at Glasgow in 1844, it is thought desirable to ascertain, with as much precision as practicable, the uses and advantages of those implements, when employed conjointly, in husbandry; and, for an approved report on the subject, the Gold, or Medium Gold Medal, according to the merits of the communication, will be awarded.

The Report must contain a description of the Implements, with measurements of their principal parts, and the cost of the whole. It must describe the purposes for which they are employed, the mode of using them, the circumstances in which they are considered to be particularly applicable, whether as respects the land to be worked, or the parties by whom it is cultivated, the advantages which may be held to belong to them in comparison with other Instruments for accomplishing the same objects, and the plan deemed most eligible for insuring the uniform sufficiency of the work performed. It must further state the expense of tillage by them per acre on different soils, the depth to which the ground, where no impervious stratum occurs, can be conveniently penetrated by them, the average quantity of work executed by them per day, when two men are employed, the effect of their use upon the produce of land, and such other particulars as may be deemed worthy of notice in illustration of the purposes to which they may be applied, or the benefits to be derived from them.

Reports to be lodged by 10th of November 1846.

3. ON THE ADVANTAGES OF DIBBLING IN SOWING.

For an approved Report, founded on actual experiment or observation, to ascertain and point out the advantages of sowing grain by the process of Dibbling—The Gold Medal or Ten Sovereigns.

Reports to be lodged by 10th of November 1846.

4. ELECTRO CULTURE.

For an approved Report on the Application of Galvanism or Electricity to Cultivation—Thirty Sovereigns.

No Essay to extend, when printed, to more than will fill ten pages of the size of the Quarterly Journal of Agriculture, unless it be accompanied with accurate experiments and results. Essays so accompanied to be preferred, *cæteris paribus*.

Competition will be open to Essays in the French, German, and Italian languages, as well as to Essays in the English language.

Essays to be lodged by 10th November 1846.

NOTE.—This Premium is proposed on the recommendation of James Adam Gordon, Esq. of Knockespock, who has placed the sum offered at the disposal of the Society, for the specific purpose indicated. Competitors are referred to the Society's Premium List for 1845, which contains a statement on the subject by R. D. Forster, Esq., M.D.

5. ANALYSES OF THE ASHES OF PLANTS.

For an approved Series of Quantitative Analyses of the Ashes of the Cultivated Plants,—or of the more common weeds growing on the different soils in Scotland—Fifty Sovereigns.

As the Society has already offered Premiums for the Analyses of Oats and Potatoes, Competitors who make choice of cultivated plants will select any of the others in common cultivation, as wheat, barley, turnips, or beans.

The more abundant weeds should also be selected for analysis, full grown healthy plants being in every case taken. Of such weeds, the following may be enumerated:—*Sinapis arvensis*, common wild mustard or charlock. *Raphanus Raphanistrum*, or jointed charlock. *Triticum repens*, couch grass, or quick grass. *Arrhenatherum avenaceum*, oat grass. *Senecio Jacobæa*, ragwort. *Bellis perennis*, common daisy. *Ranunculus acris, repens et bulbosus*, common buttercups. *Ionchus oleraceous et arvensis*, sow thistles. *Taraxacum officinale*, dandelion. *Rumex obtusifolius et crispus*, common docks. *Carduus arvensis et lanceolatus*, common thistles. *Spegula arvensis*, corn spurrey; and *Tussilago farfara*, common colt's foot.

Separate analyses should be made of the stalk of the plant and of the seeds, and in the turnip or other plants with large roots, also of the bulb. Intending Competitors are referred to the latest edition of Liebig's Agricultural Chemistry; and, for an account of the best method of ash analysis, to a paper by Drs. Will and Fresenius, on the

inorganic constituents of plants, in the Memoirs of the Chemical Society of London, Part IX.

Essays to be lodged by 10th of November 1848.

6. CONSTRUCTION OF TANKS.

For an approved Report on the most economical method of constructing Tanks for collecting liquid manure from stables, byres, and pigstyes, suitable to ordinary farm-steadings; and also on the best means of draining off from the dung-hill the liquid manure into the Tank—Ten Sovereigns.

Competitors to state the most eligible materials for the purpose, the expense, and the form and proper dimensions in proportion to the number of cattle, &c., the best mode of drawing off the contents and of applying it to the soil.

Reports to be lodged by 10th November 1846.

7. ON THE EFFECTS ATTENDING THE IMMEDIATE APPLICATION, AND THE CONTINUED RESULTS OF CERTAIN SPECIAL MANURES.

Fifty Sovereigns will be awarded in such proportions as the Directors may see proper for approved Reports as after mentioned, viz.—

1. For an approved Report of experiments made with different manures, both *separately* and also *mixed in certain proportions*, and applied either in solid or fluid form. Each experiment to be made *double*,—that is, on two separate portions of land of not less than one-eighth of an acre.

The substances employed to be Guano, Nitrate of Soda, Nitrate of Potash, Sulphate of Soda, Sulphate of Magnesia, Sal Ammoniac, Sulphate of Ammonia, Carbonate of Soda, Pearl Ash, Kelp, and Bones, or mixtures of these in specified proportions. The Ammoniacal liquor of Gas Works should also be tried; and it is particularly recommended that the refuse of any of our Manufactories, such as the Prussiate of Potash, and the animal refuse of Sugar Works, should be collected and experimented upon.

It is of importance, that the effects of such substances upon the Crops of the second, third, and fourth years should be carefully observed and reported; and though it is not indispensable that a Report on this division of the premiums, when sent in, should contain observations made for more than one year, yet a higher value will be placed upon those in which such observations are distinctly and carefully embodied.

The substances above mentioned, and any others of known composition which the experimenters may select, are to be tried after the following manner: A series of square or oblong portions, not less than one-eighth part of an acre each, are to be marked off in the field, and the different substances applied to the crop or seed upon each plot. Thus, if the substances to be experimented on be Farm-yard Manure, Guano, Bone Dust, Sulphate of Ammonia, Kelp, and Nitrate of Soda, they may be arranged as under, two plots for each.

In regard to the quantity of the several substances which ought to be laid on per acre, the Society considers it desirable that separate experiments should be made upon different quantities of each substance; for example, with kelp, the double set of experiments might be arranged thus:—

Kelp 1 cwt. per acre.	2 cwt.	3 cwt.	4 cwt.	5 cwt.	6 cwt.
6 cwt.	5 cwt.	4 cwt.	3 cwt.	2 cwt.	1 cwt.

or different proportions of two or more substances may be contrasted with each other on the same field; thus:—

Nitrate of Soda, 1 cwt.	Sulphate of Ammonia, 1½ cwt.	Nitrate of Soda, 2 cwt.	Sulphate of Ammonia, 1 cwt.	Nitrate of Soda, 1½ cwt.	Sulphate of Ammonia, 2 cwt.
Sulphate of Ammonia, 1 cwt.	Nitrate of Soda, 1½ cwt.	Sulphate of Ammonia, 2 cwt.	Nitrate of Soda, 1 cwt.	Sulphate of Ammonia, 1½ cwt.	Nitrate of Soda, 2 cwt.

The substances applied may be used either alone, or in addition to the whole or one-half of the usual dressing of farm-yard manure, or in any other way which the experimenter may think most likely to lead to important results.

As the Society considers mixtures of several substances to be the most natural and profitable mode of applying them, it strongly re-

commends that experiments with mixtures of the substances above named, should form a prominent part in the trials. The proportions of the several substances which are mixed must in all cases be stated.

As the object of the Society, in offering these Premiums, is to obtain results which will be as valuable to the science as to the practice of agriculture, it must be understood, that while the number of the experiments will be taken into account, the preference will be given to those which have been performed with the greatest accuracy. The value of the experiments will be enhanced, if accompanied with an analysis or minute description of the soil on which they are made, and means of proving the purity of the manures which were used.

The quantity by weight, and the cost of the manures employed (including carriage, and every other expense), as well as the quantity and quality of the crop produced by each, must be accurately ascertained and reported, with the nature and qualities of the soil, its exposure, drainage, and such other particulars and observations as the Reporter may deem deserving of attention.

The general conclusions and remarks which the Reporters may deduce from the results of their experiments, are to be drawn up separately from the Tables, and to be inserted immediately after their respective series of experiments; and in every instance it is hoped that these shall be as complete as the circumstances and opportunities for observation will admit.

Competitors must, along with their reports, transmit, if required, half a pound weight of the soil, collected prior to the commencement of the experiment, and the same quantity of each kind of manure employed. The number of the Premiums to be awarded will be regulated by the value of the papers received.

The Society earnestly requests the attention of landed proprietors to this very important subject, and considers that much good might result by their either instituting experiments themselves, or inducing such of their tenants to do so, as they consider qualified to undertake them.

As it is the intention of the Society to make public the practical result of these experiments, it earnestly solicits from all quarters reports of carefully conducted experiments, however small they may be. Those who have no intention to compete for the Premiums, may yet obtain results which the Society would gladly record in their Transactions.

Reports to be lodged by 10th November 1846.

2. The Society, viewing the very great importance of substantiating, by actual observation and experience, the effects which Guano and other Special Manures exert on the soil for a certain number of years after their application, offers a Premium for an approved Report on this subject, to be given in 1846, having reference to the experience of two or more preceding seasons. This Premium to be continued in 1847. It is intended chiefly for those Competitors who experimented and reported so successfully for the Premiums offered for Experiments with certain Special Manures in the three last years' printed lists; but it is open to others who may have followed the same, or similar enquiries. In all cases, the subsequent produce of the land which had received the Special Manure must be noted carefully by weight or measure, and compared with an equal portion of land that had received no Special Manure.

Blank tables for reporting the results of the Experiments in either of the divisions of this subject, will be supplied on application at the Society's Hall, under signature of the motto intended to be adopted by the Competitor.

Reports to be lodged by 10th November 184 .

8. KELP.

For an approved Report on the most economical and simple process by which Iodine, and the valuable salts which accompany it, can be extracted from Kelp or Sea Weed, especially as fitted to be carried on by the inhabitants of the Northern and Western Highlands and Islands of Scotland—The Gold Medal or Ten Sovereigns.

From the increased consumption and rise in price of Iodine, which have lately taken place, the Society has been induced to offer this Premium; and it is suggested, that as the principal salts contained in Kelp, viz. carbonate of soda, chloride of potassium, and the iodide of sodium, may be separated from each other by the simple process of lixiviation and crystalization, it might be possible to make use of one heap of sea-weed as the fuel wherewith to evaporate and chrystalize the soluble salts produced by the combustion of a preceding one. Competitors may suggest any other simple and economical process, which would admit of practical application on the large scale, by the Kelp-burners of Scotland. The Essays to contain a full account of the experiments made by the Competitors, with a description of the apparatus employed, and an estimate of the whole expense and the profits likely to result from the proposed method.

It has been stated that species of Laminaria, and other sea-weeds growing in deep water, yield more Iodine than species of Fucus found in shallow water. It will therefore be desirable to notice the species of sea-weed from which Iodine may be procured in the largest quantity.

Intending Competitors are referred to an Essay on Kelp by Dr. Fyfe, in the sixth volume of the Society's Transactions.

Essays to be lodged by 10th November 1846.

9. ON THE NUTRITIVE PROPERTIES OF TURNIPS RAISED WITH DIFFERENT MANURES.

For an approved Report on the progressive improvement and increase in weight, (during a period of at least four months) of three lots of cattle, of not fewer than four in each lot, fed on turnips and straw, or turnips and hay, in the following manner—Twenty Sovereigns.

1. Four fed on turnips grown with guano alone.
2. Four fed on turnips grown with farm-yard manure alone.
3. Four fed on turnips grown with one-half guano and one-half farm-yard manure.

The Premium is offered with the view of ascertaining the comparative feeding properties of Turnips grown with Guano, and with farm-yard manure.

The animals selected to be as nearly as possible of the same age, weight, condition, and breed, and to be treated in a similar manner in every respect.

The live weights of the animals to be ascertained before they are put up to feed, as well as at the close of the experiment, and if the animals are slaughtered, the dead weight and quantity of tallow which they yield respectively.

The turnips grown with the different manures to be on land of equal quality and in equal condition, and the quantity supplied to each lot to be weighed.

Reports to be lodged by 10th November 1846.

10. ON THE CULTIVATION OF RED CLOVER.

For an approved Report on the best mode of managing Lands which have become sick or tired (as it is termed) of common Red Clover, *Trifolium pratense*, so as to restore their capability of pro-

perly yielding that crop for hay, &c., without altering the generally practised system of rotation—The Gold Medal, or Ten Sovereigns.

Reports to be lodged by 10th November 1846.

11. ON THE IMPROVEMENT AND MANAGEMENT OF NATURAL MEADOW.

For an approved Report on the improvement of Natural Meadow by draining, top dressing, or other means, and on the subsequent management by manuring, or irrigation, and where pasturing is to be adopted, on the system whereby it may be rendered as little injurious as possible—The Gold Medal, or Plate of the same value.

Reports to be lodged by 10th November 1847.

12. ON RAISING IMPROVED VARIETIES OF AGRICULTURAL PLANTS.

For an approved Report, founded on actual experiment, detailing the means which may have been successfully employed by the Reporter for obtaining new and superior varieties, or improved subvarieties, of the different cultivated Grains and Grasses, Clovers, Beans, Peas, Turnips, Potatoes, or other Agricultural Plants, either by minute attention to the selection of the Seed, by hybridation, or such other means as may have been found efficacious—The Gold Medal, or Plate of the same value.

It is necessary that the varieties and subvarieties reported upon shall have been proved capable of reproduction from seed, and also that the relation they bear to others, or well known sorts, shall be stated. The Reporter is farther requested to mention the effects that he may have observed by different soils, manures, &c.,* produced on the plants forming the subjects of report, and how far he may have ascertained such effects to be lasting.

NOTE.—Should any improved variety reported upon be the result of direct experiment by cross impregnation, involving considerable expense and long-continued attention, a higher Premium will be awarded.

Reports to be lodged by 10th November 1846.

13. POTATO BLOSSOMS.

For an approved Report on the results obtained, as to the quality and quantity of the crop, by picking the blossoms from the stems of the potatoes, instead of allowing the germs to ripen into seed apples—The Medium Gold Medal.

The trials to be made with different varieties of Potatoes, and on portions of not less than one-eighth of an acre each, care being taken in removing the flowers that the stems are not injured.

The Reports to be lodged by 10th November 1846.

14. DISEASE IN POTATOES.

1. CHEMICAL INVESTIGATION OF DISEASE IN POTATOES.

For an approved Analysis of sound and unsound Potatoes, and of the soils on which they grew—Fifty Sovereigns.

The object of the Society is to ascertain if, by the aid of chemical analysis, any light can be thrown on the cause of disease in Potatoes, or upon the remedy to be applied. The analysis of the several varieties of Potato to embrace both their organic and inorganic constituents. The details of the experimental researches, which will include Potatoes both at taking up and at seed time, and the method of analysis adopted, to be given in the Report.

Reports to be lodged by 10th November 1846.

2. BOTANICAL INVESTIGATION OF THE RECENT DISEASE IN POTATOES.

For an approved Physiological Essay on the Disease which has recently effected Potatoes—The Gold Medal, or Ten Sovereigns.

The Author is expected to give an account of the structure of the Potato in the healthy state, and to notice the changes which take place in it during the progress of the disease.

It will also be of great importance if the Author can suggest any mean by which the disease may be prevented or cured.

Reports to be lodged by 10th November 1846.

15. VEGETABLE PRODUCTIONS OF INDIA, CHINA, AND AMERICA.

For an approved Report, on the Hardy or supposed Hardy Trees, and useful Herbaceous Plants, including Grains and Grasses, of China, the Himalaya country, the Falkland and South Sea Islands, California, and the high north-western districts of America, where such climate exists as to induce the belief that the Plants may be beneficially introduced into the cultivation of Scotland—The Gold and the Medium Gold Medals, according to the merits of the communications.

There being reason to believe, that in addition to the useful vegetable, productions which have of late years been introduced from Upper

India, California, &c., many others may exist in the same regions, and in China, equally well suited to this climate, the Society has been induced to offer the above Premiums, for the purpose of obtaining the fullest information, relative both to the unintroduced sorts, and those already known in this country, with the view of encouraging the introduction of the former, and the more extended culture of the latter. Reporters are, therefore, required to give the generic and specific names, with the authority for the same—together with the native names, in so far as known; also, to state the elevation of the locality and nature of the soil in which they are cultivated, or which they naturally inhabit, with their qualities or uses; and it is further requested, that the descriptions be accompanied, in so far as possible, with specimens of the plants and their fruit, seed, timber, or other products.

The transmission of living plants in cases covered with glass, may be attempted where practicable, the cases being exposed to light, and the external air being excluded, and almost no water given during the voyage. Where this plan is adopted, smaller seeds, berries, or heps, may be thickly mixed with the soil or earth in which the plants are placed. Seeds may be sent home in the cones, wrapped in brown paper, packed in a box, to be kept in a cool, airy part of the cabin, but on no account in the hold, nor in close tin cases. In the event of the seeds of Coniferæ being separated from the cones, with the view of lessening the bulk and weight of packages, intended for overland carriage, hasty and severe heating, in extracting the seeds, should be carefully avoided.

Reports to be lodged by 10th November, in any year.

16. TUSSAC GRASS.

For an approved report, founded upon actual experience, on the cultivation in this country, of the Tussac Grass, *Dactylis cæspitosa*—The Medium Gold Medal.

Seeds of this valuable grass having been lately introduced into Scotland from the Falkland Islands, where it is said to be found growing in great luxuriance, chiefly on peaty soils, within the influence of the sea. It is also said to grow on sandy soils under the same influence, and where the climate is similar to that of Great Britain.

This Premium is offered, in order that the result of experiments made may be publicly known, and to ascertain if its extended cultivation in this country would be beneficial.

Parties who have received portions of the parcels of seed transmitted

by the Colonial Secretary are expected to report on the results of their experiments, including all the particulars regarding them, whether successful or not.

Reports to be lodged by 10th of November 1846.

17. FEEDING OF STOCK.

For an approved Report of Experiments for ascertaining the actual addition of weight to *growing* and to *fattening* stock of all kinds, respectively, by the use of different kinds of food, as well as the exact effect of weighed quantities of food of different kinds, upon the quantity and quality of milk, in full grown milk cows *in calf and not in calf*—Twenty Sovereigns, or plate of that value.

The attention of the experimenter will be drawn to the effects of Turnips, Carrot, Beet, Potatoes, or other roots, as well as to those of Beans, Oats, Barley, and Oil Cake, and to the opinion that warmth is equal to a certain amount of food.

Before commencing the comparative experiments, the animals must be fed on equal quantities of the same kinds of food for some weeks previously.

The animals tried against each other should be, as nearly as possible, of the same age, weight, condition, maturity, and purity of breed. Different breeds may be compared, and this will form an interesting experiment of itself.

The animals are to be treated, in every respect, alike. The food and drink to be regularly weighed and measured, and samples of the food (when this can be done,) carefully analysed. The live and, if killed, the dead weights of the animals, at the close of the experiment, should be ascertained, and the quantity of tallow which they yield.

Reports to be lodged by 10th November 1846.

18. ON THE STRUCTURE AND PROPERTIES OF WOOL.

For an approved Report on the Structure, Conformation, and Physical Properties of Wool; and on the Nature and Uses of the Sebaceous Secretion of the Skin of the Sheep—the Yolk—The Gold Medal, or Ten Sovereigns.

Under the former head must be, included a detailed description of the different kinds of Wool which are at present cultivated in the United Kingdom, with deductions as to their comparative value and utility for manufacturing purposes; and under the latter, the special influences which the yolk exerts upon the Wool, the necessity or inuti-

lity of artificial salving, and in those circumstances where such has been used, the safest and most efficacious methods of removing it from the fleece, and the bleaching and purifying of the Wool from the "gilting" that may have resulted from its application.

Reports to be lodged by 10th of November 1847.

19. REPORTS ON IMPROVED RURAL ECONOMY ABROAD.

For approved accounts, founded on personal observation, of any useful practice or practices in Rural or Domestic Economy, adopted in other countries, which may seem fitted for being introduced with advantage into Great Britain—The Gold or Silver Medal, according to the merits of the communication.

The purpose chiefly contemplated by the offer of this Premium is to induce gentlemen who may visit other countries, to take notice of, and record such particular practices as may seem calculated to benefit their own country in the branches of the arts referred to. The earliest opportunity will be taken of communicating the Reports to the public.

Reports to be lodged by 10th November in any year.

ESSAYS AND REPORTS.

§ II. WOODS AND PLANTATIONS.

1. PREMIUMS FOR EXTENSIVE PLANTING.

To the Proprietor who shall, within a period of five years immediately preceding, have planted on his property the greatest extent of ground, not being less than 150 acres, and who shall communicate to the Society a satisfactory report of his operations, embracing the expense, description of soil, age, and kind of trees planted, the number of each sort per acre, mode of planting, extent of "beating up," and general progress of the plantation, with such observations as his experience may suggest—The Gold Medal.

Although not a Condition, it will be a recommendation, that the Report contain a notice of the underlying rocks, and of the geological features of the district.

Reports to be lodged by the 10th of November in any year.

2. REPORTS ON RECENT PLANTATIONS.

For an approved Report, by a proprietor, of plantations formed by him on his own property to an extent of not less than fifty acres, within a period of not more than ten nor less than four years preceding the date of his Report—The Gold Medal.

The Report should comprehend every interesting particular: among others, the exposure and altitude of the place, and general character of the soil—whether lime has been used, and, if so, its mode of application and apparent effect—the same of any sort of manure or other fertilizing substance—the mode of fencing and of planting adopted—the kind of trees planted, and the number of each kind per acre—their relative progress—the proportion of blanks and deaths at the end of three years—the system of management—the state of the plantations at the date of making the report—and the expense per acre, as nearly as can be calculated.

Reports to be lodged by 10th November in any year.

3. ON PLANTING WITHIN THE INFLUENCE OF THE SEA, OR ON EXPOSED BARREN TRACTS.

For an approved Report on successful Planting within the influence of the sea, or on very bleak, peaty or sandy tracts, founded on observation of the habits and appearance of the different sorts of trees considered as best suited for such situations—The Gold Medal, or Plate of the same value.

Great disappointment having arisen to landed proprietors, in different parts of this country, in planting Waste Grounds, especially on the sea coast, the above Premium is offered, with a view of directing attention to the subject.

Information is particularly desired regarding trees calculated for growing in situations unfavourable to most of the more generally cultivated sorts, as in bleak heaths, barren sandy links, and exposed maritime situations; and with respect to the last of these, the value of the *Pinus Pinaster*, or the more hardy variety of that tree from the downs of Bourdeaux, (called *Pinus maritima minor*,) should be ascertained.

The reporter is requested to specify the nature of the surface soil, and although not a Condition, it would be a recommendation that the Report contain a notice of the underlying rocks, and of the geologi-

cal features of the District, with its elevation, exposure, and distance from the sea.

Reports to be lodged by 10th November in any year.

4. FORMATION OF ARBORETUMS.

For an approved Report by a proprietor in Scotland on the formation of the most varied, extensive and judiciously arranged collection of hardy, or supposed hardy, forest and ornamental trees—either *species* or marked *varieties*—Twenty Sovereigns, or a piece of Plate of that value.

There is reason to believe that important arboricultural knowledge may be obtained by the judicious formation of Arboretums in various parts of the country, where opportunities may be afforded of comparing the growth and habits of the different species and varieties of Hardy Trees. It is required, therefore, that such Arboretum shall be formed, so as to afford proper space for the future development of each specimen. The Report must specify the date of planting, with the age and height of each specimen at that time. It must also state, whether the tree is a seedling, a cutting, a layer, or a grafted plant; and if the latter, on what stock it had been grafted. Information must be afforded, relative to the nature and previous preparation of the soil, the altitude and exposure of the place; mentioning also, whether it be in the vicinity of a large town, manufactory, lake, or marsh, where smoke or hoar frost may be supposed to exert their influence on the growth of the plants generally, or on any particular section or sections of them. Any means used for protecting or fencing the Arboretum should be stated.

The Report must be accompanied with a correct plan of the Arboretum, on a scale of not less than two inches to the chain, showing the relative disposition of each specimen, which may be marked on the plan, thus (2.) the figure in the centre, corresponding with that attached to the name contained in the Report, or in an accompanying List. In cases where such a plan cannot well be made, (as, for example, when an Arboretum is formed on the sides of an approach to a mansion-house, which will often be found an admirable locality for the purpose,) an accurate description of the distribution and arrangement of the trees must be given.

Reports to be lodged by 10th November in any year.

5. DISEASES OF THE LARCH.

For an approved Report on the Diseases which prevail in the Larch Plantations of Scotland.—Twenty Sovereigns, or Plate of the same value.

The writer is required to describe the different diseases commonly called *heart rot*, *canker*, and *white bug*, and to state the manner in which they appear to affect various parts of the plant, as the root, the trunk and bark, the leaves, and the fruit or cones. He is required to direct attention to the annual layers in the wood of trees that have been felled, so as to ascertain, if possible, the period or year in which a decay of vigour first exhibited itself in the plants affected.

The writer is farther requested to state the age at which the diseases most generally manifest themselves; the situations in which they have chiefly appeared, with respect to the geological formation; the wetness, dryness, stiff nature, or other conditions of the soil or subsoil; elevation, exposure, checks of growth from pruning or other causes, and evils arising from inattention to proper thinning; and to mention whether the larch had been planted soon after a previous crop of Scotch fir or other timber had been removed from the ground. He is especially required to observe, whether, and under what circumstances, trees have, in any case, escaped injury, or whether from any obvious cause the diseases, after appearing, have spontaneously ceased; and he is requested to ascertain, as far as possible, the kinds of seed that have been used, whether they have been derived from the cones of trees cultivated in this country, or procured from the forests of Switzerland and the Tyrol.

Farther, as it is highly important to ascertain if any means exist of averting the progress of decay, and restoring the vigour of the trees affected, experiments with this view will be considered with especial favour.

The Report must be accompanied with such specimens of the timber, soils, rocks, &c., as may tend to illustrate any particular remarks or opinions of the author.

Reports to be lodged by 10th of November 1846.

6. FOREST TREES, OTHER THAN CONIFERÆ.

For an approved Report on the more extended introduction of hardy, useful, or ornamental Trees, other than Coniferæ, which have not hitherto been generally cultivated in Scotland—The Gold Medal.

The Report should specify, as distinctly as possible, the kinds of trees experimented upon, giving their popular names, or those by which they are known in the nursery gardens, and, when practicable, their scientific or botanical names. The nature of the locality of the plantation should likewise be described, as to soil, exposure, shelter, and elevation above the level of the sea. The adaptation of the trees for use or ornament should be mentioned. Particular attention is directed to the various kinds of American Elms, the Hymalayan Oaks, Ashes, and Sycamores; to the *Quercus Mirbeckii* of Algeria, the *Planera Richardi*, and the *Tilia Heterophylla*. Attention should also be given to the *Populus Monilifera*, black Italian Poplar, which affords useful timber for many country purposes. The Beeches of Terra del Fuego, and of the Falkland Islands, as well as the Brown Birch of South America are still very rare in this country, but well worthy of attention.

Reports to be lodged by 10th November in any year.

8. ON RECENTLY INTRODUCED CONIFERÆ.

For an approved Report on the results attending the culture of the recently-introduced Coniferous Trees—The Gold or Silver Medal, according to the merits of the communication.

It is the wish of the Society to ascertain how far the various recently introduced kinds of the Pine or Fir Tribe are likely to prove either useful or ornamental trees in the climate of Scotland; such as *Cedrus Deodara*, *Pinus excelsa*, and *Abies Morinda*, from Nepaul; *Abies Douglasii* and *A. Menziesii*, from North West America and California; *Araucaria imbricata*, from Chili; *Cryptomiria Japonica* or Japan Cedar, from Shanghai in China, *Pinus Austriaca*, or Black Pine, and *Pinus Cembra Helvetica*, or Swiss Stone Pine. Information is therefore desired as to the Soils and exposures which seem best adapted for these different species, or as many of them as have been cultivated by the Reporter; also as to the advantage of sheltering any of them while young, by means of Scotch Firs, or Spruces, as nurses. Comparative statements should be given, as far as possible, between their respective progress in growth and that of the more commonly cultivated sorts, such as Scotch Fir, Larch, Spruce, and Silver Fir; and their comparative general qualities, as forest or ornamental trees, should also be mentioned.

Reports to be lodged by 10th November in any year.

9. MORE EXTENDED INTRODUCTION OF KNOWN SPECIES OF THE FIR TRIBE.

To the person who shall, within six years from 1842, inclusive, have introduced from any part of the world, seeds capable of germination, the produce of hardy species of the Fir Tribes which have been already introduced into Britain, but of which only a few plants have been raised—The Gold or the Silver Medal, or a piece of Plate of such value as the Directors may, in the circumstances of the case, deem adequate.

It is required that the quantity of seeds of each species imported shall be sufficient to afford at least 250 seedling plants; and farther, that before the Premium be awarded, the number of seedling plants of each species actually raised in Scotland, shall not be less than 50. Attention is particularly directed to *Araucaria imbricata, Pinus ponderosa, Lambertiana,* and *Sabiniana;* to *Abies Douglasii nobilis grandis,* and *Menziesii;* and to *Taxodium sempervirens* which last is abundant in the vicinity of St. Francisco, and throughout the low sandy plains of California. Intending Competitors are referred to the Premium No. 15, § 1, Class A., Essays and Reports, as to the manner in which seeds ought to be transmitted to this country. Reports to be lodged by 10th November 1848.

ESSAYS AND REPORTS.

§ III.—WASTE LANDS.

1. IMPROVEMENT OF A SPECIFIED EXTENT OF WASTE LAND BY TILLAGE.

1. To the Proprietor or Tenant in Scotland who shall transmit to the Society an approved Report of having successfully improved, and brought into profitable tillage, within a period of five years immediately preceding the date of his communication, an extent of waste and hitherto uncultivated Land, not being less than fifty acres—The Gold Medal.

2. To the Tenant in Scotland who shall transmit to the Society an approved Report of having, within the period of three years preceding the date of his Report, successfully improved, and brought into profitable tillage, an extent of waste and hitherto uncul-

tivated Land, not being less than twenty acres on the same farm—The Silver Medal.

The Reports in competition for both Premiums may comprehend such general observations on the Improvement of Waste Lands as the writer's experience may lead him to make; but they are required to refer especially to the land reclaimed, (which, if not in one continuous tract, must be in fields of considerable extent) to the nature of the soil, the previous state and probable value of the ground, the obstacles opposed to its improvement, the mode of management adopted, and in so far as can be ascertained, the produce and value of the subsequent crops; and the land must have borne one crop of grain, at least, previous to the year in which the Report is made. The Reports must be accompanied by a detailed statement of the expense, and by a certified measurement of the ground. Competitors for the more limited extent improved will observe, that, having gained the Silver Medal, it shall not be competent to include the same improvement in a subsequent claim for the Gold Medal.

Reports to be lodged by the 10th of November in any year.

2. IMPROVEMENT OF MUIR OR MOSS GROUND BY TOP-DRESSING.

To the Proprietor or Tenant in Scotland who shall transmit to the Society an approved Report of having, within the three years immediately preceding the date of his Report, successfully improved the pasturage of not less than thirty acres of Muir or Moss Lands, by means of Top-Dressing without Tillage—The Gold Medal.

The Society has been given to understand, as the result of actual experiment, that a great extent of muir and moss land in Scotland may be converted into, comparatively speaking, superior pasturage, by top-dressing without tillage; and it is, therefore, desirous of encouraging such experiments. Reports must state the particular mode of top-dressing adopted, and the expense per acre, and as many particulars as possible regarding the previous natural products of the soil, the elevation of the ground, and the changes produced by the application of the top-dressing, and also whether, and to what extent, the lands had been at the same time, or previously, drained.

Reports to be lodged by 10th November in any year.

ESSAYS AND REPORTS.

§ IV.—AGRICULTURAL MACHINERY.

1. ON THE COMPARATIVE ADVANTAGES OF DIFFERENT DESCRIPTIONS OF MACHINES FOR THRASHING GRAIN.

For an approved Report of a series of experiments, properly authenticated, showing the comparative results of thrashing a given quantity of the same kind and quality of grain by the common Scotch Thrashing Machine, by the Peg Drum Machine; and also, where practicable, by the English High Speed Beater—Twenty Sovereigns.

Each machine employed in the experiments must be fitted with shaking and dressing, or winnowing machinery, so that the grain may be delivered from the machine fit for market. The quantity thrashed in one experiment on each machine is not to be less than five quarters, and the experiment repeated three times, but it is not essential that the kind and quality of the grain be the same for each repetition.

For the convenience of comparison, it is desirable that the *power* employed should in all cases be horses, and the same set in all cases, but if it is found necessary to use steam machines, non-condensing engines should be preferred as being more easily compared—and in such cases the pressure of the steam per square inch in the boiler must be carefully registered, and, if possible, also in the cylinder, by means of the steam indicator. The diameter of the cylinder, length of the stroke of piston, and the number of strokes per minute, to be also noted.

Competitors, in stating their results, are requested to have regard to the quantity of grain thrashed—the time and power employed—the quality of the thrashing, whether clean or foul—the state of the straw, whether it is broken or remaining entire, by comparison from the different machines; and also the condition of the dressed grain, whether any portion of it has been broken or bruised. The average length of straw in the sheaf, and any other particulars that may appear to the experimenter to be of importance, to be also noticed.

Reports to be lodged by 10th November 1846.

2. INVENTION OR IMPROVEMENT OF IMPLEMENTS OF HUSBANDRY.

To the person who shall invent or improve any Instrument or Machine applicable to Husbandry or Rural Economy, which, from its utility in saving labour or expense, simplicity, or cheapness of construction, or other circumstances, shall be deemed by the Society deserving of public notice—The Gold or the Silver Medal, or such sum in money, taking into account the value of the Model, as the communication shall appear to deserve.

The account of the implement must be accompanied by a model, made to a scale of three inches to the foot, to be deposited, if approved, in the Society's Museum. The model to be formed of wood or metal; and the notice or description transmitted with it must specify, according to the best of the inventor's abilities, the purpose or advantage of his invention or improvement. When machines or models are transmitted, it must be stated whether they have been elsewhere exhibited or described. Models and descriptions may be lodged at any time with the Secretary.

ROCKS, MINES, AND MINERALS.

This section of the Premiums has been suspended, there being in hand a considerable accumulation of unpublished Surveys and Reports.

CLASS B.

CROPS AND CULTURE.

1. NEW PLANTS ADAPTED TO FIELD CULTURE.

For an approved Report of any new species or variety of useful Plant adapted to the ordinary field-culture of Scotland—The Gold or Silver Medal, or a Piece of Plate, according to the merits of the communication.

Attention is directed to the raising or procuring of new varieties of cereal grains and leguminous plants, as well as of the more useful herbage and forage plants, and particularly of a nutritious and succulent vegetable for Spring food for Ewes, to preserve them in Milk in

seasons when Grass is late, and Turnips have lost their properties for that object.

Specimens of the Grains and Plants to be transmitted, if this can conveniently be done.

Reports to be lodged by 10th November in any year.

2. SEED FOR CORN AND OTHER CROPS.

The Society, with the view of aiding Local Associations and Individuals in the improvement of the different varieties of Grain, &c., best adapted for their respective localities, offers for each of the years 1846 and 1847, in six several Districts, the Society's Silver Medal to the Grower of the best of each of the following Seeds raised in the District in which the Competition is held:—

1. For the best and approved parcel of any named variety of White Seed Wheat.
2. For the best and approved parcel of Red Seed Wheat.
3. For the best and approved parcel of Chevalier Barley.
4. For the best and approved parcel of any other named variety of Seed Barley.
5. For the best and approved parcel of Potato Oats.
6. For the best and approved parcel of Hopetoun Oats.
7. For the best and approved parcel of any other named variety of Early Seed Oats.
8. For the best and approved parcel of any named variety of late Seed Oats.
9. For the best and approved parcel of any named variety of Field Bean.
10. For the best and approved parcel of any named variety of Early Field Peas.
11. For the best and approved parcel of any named variety of late Field Peas.
12. For the best and approved parcel of Common Tares or Vetches.
13. For the best and approved parcel of perennial Rye Grass Seed.
14. For the best and approved parcel of Timothy Grass Seed.
15. For the best and approved parcel of any variety of Potato.

CONDITIONS.

1. Local Associations and individuals intending to institute competitions for any of the above medals, to lodge with the Secretary of the Society a statement of the diffe-

rent descriptions of seeds intended to be competed for, with a satisfactory guarantee that Money Premiums shall be given to the extent of not less than £2 sterling for each variety of such seeds.

2. In each District a Convener, to be appointed by the Society, with the aid of the other Members of the Society in the District, and of the Local Association or Individual contributing the Money Premiums, will fix the time and place of Competition, appoint the Judges, and make all other necessary arrangements.

3. The quantity shown in Competition by each grower must not be less than three quarters of each variety of grain, two quarters of Beans, Peas, Vetches, and Grass Seeds, and half a ton of Potatoes.

4. The Judges shall be guided in their awards—1st, By the purity of the Seed;—2d, By its freeness from extraneous Seeds;—and, 3d, Where there is an equality in these respects, by the weight.

5. Each Competitor to whom a medal shall be adjudged, must, immediately after his preference is declared, transmit to the assistant to the curator of the Society's Museum, free of expense, a sample of the seed for which the medal shall have been awarded; and when the seed consists of grain or grass seed, the quantity to be transmitted is not to be less than half a gallon.

6. The Conveners in the Districts in which Competitions are to be held, will be furnished with blank schedules for making up returns of the awards of the Judges, which must be transmitted to the Secretary within fifteen days from the dates of the Competitions.

7. The returns must show, as accurately as possible, the quantity of produce per imperial acre, as also the altitude, exposure, and nature of the soil on which the crops were raised, together with the dates of sowing and reaping, and, in the case of grain or grass seed, the weight per bushel.

8. Schedules, containing returns of Competitions, must, at latest, reach the Secretary by the 10th November in the year in which the Competitions take place.

First District—The County of Nairn: Premiums to the growers of—

1. The best approved parcel of any named variety of White Seed Wheat.
2. The best approved parcel of any named variety of Seed Barley.
3. The best approved parcel of any named variety of Early Seed Oats.
4. The best approved parcel of any named variety of late Seed Oats.
5. The best approved parcel of perennial Rye Grass Seed.

Second District—Dalkeith: Premiums to the growers of,

1. The best approved parcel of Potato Oats.
2. The best approved parcel of Hopetoun Oats.
3. The best approved parcel of Barbachlaw Oats.
4. The best approved parcel of Dun Oats.
5. The best approved parcel of any other variety of Early Seed Oats.

6. The best approved parcel of any other variety of Late Seed Oats.
7. The best approved parcel of Chevalier Barley.
8. The best approved parcel of any other variety of Seed Barley.
9. The best approved parcel of Hunter's Wheat—crop 1845.
10. The best approved parcel of Hunter's Wheat—crop 1846.
11. Any other variety of White Seed Wheat—1846.
12. Any other variety of Red Seed Wheat—1846.

First District—Convener, William Mackintosh, Esq. of Geddes.
Second District—Convener, Robert Scott Moncrieff, Esq.

The Premiums in these districts will be awarded under the general conditions above mentioned.

Applications from any of the above districts which may desire to have the Premiums continued for another year, or from other districts which have not already had the Premiums, to be lodged with the Secretary of the Society by 10th of November next. The Directors will select from the applications the six Districts for 1847.

3. TURNIP SEED.

1st, Swedish Turnip.

District—The Counties of Berwick and Roxburgh.

To the person in the Counties of Berwick and Roxburgh who shall have grown, in the year 1846, a quantity of not less than ten quarters of the most approved quality of seed of any variety of yellow-fleshed Swedish Turnip, either from the best and purest approved stock of mature selected and transplanted bulbs, or from turnips produced from the seed of bulbs, which shall have been so selected and transplanted—The Gold Medal, or Ten Sovereigns.

2d, Yellow Field Turnip.

District—The Counties of Aberdeen, Kincardine, Moray, and Banff.

To the person in the Counties of Aberdeen, Kincardine, Moray, and Banff, who shall, in the year 1847, have grown a quantity of not less than ten quarters of the most approved quality of seed of any variety of Yellow Field Turnip (Swedes excepted,) from the best

and purest approved stock of mature selected and transplanted bulbs, or from turnips produced from the seed of bulbs which shall have been so selected and transplanted—The Gold Medal or Ten Sovereigns.

3D, White Globe Turnip.

District—The County of Dumfries.

To the person in the County of Dumfries who shall, in the year 1847, have grown a quantity of not less than ten quarters of the most approved quality of seed of any variety of White Globe Turnip, from the best and purest approved stock of mature selected and transplanted bulbs, or from turnips produced from the seed of bulbs, which shall have been so selected and transplanted—The Gold Medal or Ten Sovereigns.

Considerable disappointment and loss having been experienced of late years by turnip growers in certain districts, from inattention to the proper selection and management of seed crops, and their isolation from other similar crops, the Society offers the above Premiums with the view of directing attention to, and encouraging the more careful growth of turnip seeds from selected and transplanted stocks.

Competitors for 1846 must have lodged intimation of their intention with the Secretary of the Society, on or before the 1st of December last; and Competitors for 1847 must make similar intimation on or before the 1st of December next, so as to admit of an inspection of the growing crops being made by persons appointed by the Society, who will be guided in their opinions,

1st, By the purity of the stock.
2d, By the symmetry of the form.
3d, By the apparent hardiness of the variety.
4th, By its apparent capability of yielding a bulky or heavy crop.
5th, By the quality of the seed raised.

Competitors in 1846 are required to lodge, on or before the 10th November next, and those in 1847, on or before the 10th November in that year, a properly certified statement of the extent of ground they had under crop, and the quantity of clean marketable seed harvested, accompanied with a fair sample of not less than one peck, and twenty plants of each variety of the turnip, as specimens, to be delivered free at the Society's Museum, George IV. Bridge, Edinburgh.

4. GREEN CROPS ON HILL FARMS.

The Society, with the view of aiding Local Associations in their efforts for improving the management of Turnip and Potato Cultivation on *Hill Farms*, which has been represented as being still extremely defective in several districts, offers the following Premiums for Competition in 1846 and 1847, the one-half of the amount to be contributed by each Association claiming the Premiums.

For the best managed Crop of Potatoes or Turnips in respect to the cleaning of the land, and the general good working of the Crop—Three Sovereigns.

For the second best ditto—Two Sovereigns.

For the third best ditto—One Sovereign.

Applications have been made for these Premiums in 1846 by

The Glenkens Agricultural Society, Stewartry of Kirkcudbright—Convener, William Scot, Esq. of Craigmuic.

The Kintyre Agricultural Society, County of Argyle—Convener, Richard Campbell, Esq. of Auchinbreck.

CONDITIONS.

1. The proportion of Green Crop, of Turnip, and Potato, shall be one-third of the land on the farm, which shall be ploughed that year.
2. The minimum extent of land under green crop, as above, shall be six imperial acres.
3. The proportion of Turnip shall be at least one-fourth of the green crop as above.
4. The whole land of the farm under green crop shall be shown in competition.
5. The Premiums are offered for Competition in the years 1846 and 1847. Applications by Local Associations, accompanied by guarantees for payment of one-half of the amount of the Premiums, to be lodged with the Secretary of the Society on or before the 1st day of May in each year.
6. The names of intending Competitors to be intimated to the Conveners to be appointed by the Society, on or before the 15th day of May in each year; and it shall then be competent to the Convener to add such others to the List as he may think deserving of encouragement, but after that day no additional name shall be received.
7. There must not be fewer than two Competitors in each District; and the Convener and Committee shall have power to withhold the Premiums, or divide them in such manner as they shall consider most equitable. The gainer of the first Premium to be precluded from competing in the subsequent year. In the event of there being only one Competitor, it will be in the power of the Committee to vote a portion of one of the Premiums, if his merits shall appear to be such as to deserve it.
8. The Inspectors to be fixed by the respective Conveners shall decide the Premiums, with the assistance of such other Members of the Society as may attend.

The awards to be made and intimated to the Secretary of the Society on or before the 1st of December in each year; and Conveners are particularly requested to state in their reports the proportion of each lot cropped, as above mentioned, and to offer any suggestions which they may consider of importance.

5. PREMIUMS FOR GREEN CROPS ON SMALL POSSESSIONS.

The Society, with the view of improving the cultivation of small possessions, by the introduction of Green Crops, will give the following Premiums in the Districts after-mentioned, viz. ;—

The PARISHES OF KENMORE AND KILLIN, including the portion of the parish of WEEM on LOCH TAYSIDE.—Convener, the Marquis of Breadalbane.

The DISTRICT OF GLENKENS, Stewartry of Kirkcudbright.—Convener, W. G. Yorstoun, Esq. of Garroch.

The ISLANDS OF ORKNEY.—Convener, William Balfour, Esq., Birston Brae.

The ISLAND OF SKYE.—Conveners, Lord Macdonald and Norman Macleod, Esq. of Macleod ; in their absence, their Factors are authorized to act.

PREMIUMS.

For the best and approved Green Crop—Three Sovereigns.
For the second best do.—Two and a-half Sovereigns.
For the third best do.—One and a-half Sovereign.
For the fourth best do.—One Sovereign.

CONDITIONS.

1. The Competition to be limited to Tenants occupying not more than 40 acres of land.

2. The quantity of ground under Green Crop to be fixed by the Convener,—at least one-half of the Green Crop to be Turnips, and that portion which is in Green Crop in 1846 must be sown out, with sufficient quantities of Clovers and Rye Grass, with the White Crop in 1847.

3. The names of intending Competitors to be intimated to the Conveners appointed by the Society, on or before the 15th day of May 1846; and it shall then be competent to the Convener to add such others to the List as he may think deserving of encouragement, but after that day no additional name shall be received.

4. There must not be fewer than two Competitors in each district; and the Convener and Committee shall have power to withhold the Premiums, or divide them in such manner as they shall consider most equitable. The gainer of the first Premium to be precluded from competing in subsequent years. In the event of there being only one Competitor, it shall be in the power of the Committee to vote a portion of one of the Premiums, if his merits shall appear to be such as to deserve it.

5. The Inspectors to be fixed by the respective Conveners, who, with the assistance of such other Members of the Society as may attend, shall decide the Premiums.

The awards to be made and intimated to the Secretary of the Society on or before the 1st of December in each year; and Conveners are particularly requested to state in their reports the proportion of each lot cropped, as above mentioned, and to offer any suggestions which they may consider of importance.

Similar Premiums will be given in four additional Parishes in the year 1847, and three succeeding years, on guarantees for the payment of one-half of the Premiums being lodged with the Secretary on or before the 1st of October 1846.

6. PLOUGHING COMPETITIONS.

Premiums to Ploughmen for improvement in Ploughing having for some years been given very generally over the country by the resident Gentlemen and Local Farming Societies, the Highland and Agricultural Society has, in the meantime, discontinued its money prizes ; but, being desirous of encouraging improvement in this branch of husbandry, the Society will give its Silver Plough Medal to the Ploughman found to be the best at such competitions, whether he has gained the Medal at a previous Competition or not, provided not fewer that fifteen Ploughs shall have started, and that Premiums in money to an amount not less than Three Sovereigns shall have been awarded. It shall be imperative on the Judges of the competition, in deciding on the merits of the competitors, to take into consideration the time occupied in ploughing the ground assigned to them respectively ; and in all cases to give the Society's Medal to the competitor found entitled to the first money Premium in addition to it. The Medal will be issued upon a report from one or more Members of the Society, who shall have actually attended the competition. This Report must state,

1. The date and place of Competition.
2. That the Member who signs the Report was present at the Competition.
3. The number of Ploughs which competed.
4. The number and amount of the money Premiums awarded.
5. The names of the Ploughmen to whom the Premiums were awarded ; and, if servants, in whose employment they are ; the estimated quantity of ground assigned for ploughing ; the time occupied by the competitors respectively in ploughing it ; the sum voted to each ; and that the Society's Medal was awarded to the gainer of the first money Premium.

The Report must be lodged with the Secretary, at the Society's Hall, within three months from the date of the Competition, and must state the above particulars, otherwise the Medal will not be issued.

NOTE.—The Society has been induced to make the stipulation as to *time* forming an element in the merits of Competitors, from having observed the bad effects of omitting it in some Competitions, by which the Ploughmen were led in some measure to underrate the importance of time in Ploughing, as well as in all other farming operations; and the Society would suggest for the consideration

of the resident Gentlemen and Local Societies, that on land of average tenacity the rate of Ploughing should not be less than will turn over an imperial acre in ten hours.

The Society would also recommend, that in estimating the work of Competitors, attention should be directed to its sufficiency below, as well as to its neatness above, the surface.

CLASS C.

LIVE STOCK—DISTRICT COMPETITIONS.

§ 1. CATTLE.

PREMIUMS FOR IMPROVING THE BREED OF CATTLE IN THE FOLLOWING DISTRICTS.

1. *The Parishes of Maybole, Kirkmichael, Straiton, Dailly, and Kirkoswald, in the County of Ayr.*
2. *The County of Banff, excepting the Parishes of Inveravon, Kirkmichael, Mortlach, and Aberlour, and those parts of Banffshire in the Turriff District.*
3. *The County of Caithness.*
4. *The County of Dumbarton, excepting the detached Parishes of Cumbernauld and Kirkintulloch, and also that portion of the County of Renfrew situated on the right bank of the River Clyde.*
5. *The District of Lorn, Argyllshire, comprehending the country from Kilmelford to Lochaw, by Lochavich, and the Water of Avich; from thence by Lochaw to the Water of Tettle, including the country of Glenorchy to the head of Lochleven; and from thence to Linealich by the Sound of Corryoreckan to Lochmelford.*
6. *The Parishes of Tullynessle and Forbes, Keig, Leslie, Alford, Touch, Monymusk, Kenmay, and Cluny.*
7. *The District of Mull and Morven, Argyllshire, comprehending the Islands of Mull, Ulva, Icolmkill, Tyrie, Coll, Inchkenneth, Gometra, and small Isles adjacent, the Parish of Morven, and Lands of Kingerloch.*
8. *The Counties of Moray and Nairn.*
9. *The Island of Skye.*
10. *The Parishes of Auchterarder, Blackford, Muthil, Comrie, Monzie-vaird and Strowan, Crieff, Monzie, Fowlis Wester, Madderty and Trinity Gask, in the County of Perth.*

Class I.

1. For the best Bull, above two and under eight years old, to be exhibited at the Competition in each of the two Districts, Nos. 5 and 6, as above described, *bona fide* the property of a Proprietor, Factor, or Tenant, and kept in his possession from the 20th day of May preceding the Competition—The Honorary Silver Medal.

2. For the best Bull, above two and under eight years old, *bona fide* the property, and in possession of any Tenant in each of the said two Districts, kept on his farm within the District, from the 20t day of May preceding the Competition—Ten Sovereigns.

3. For the second best Bull, of the same age, in each of the said two Districts, the property, and in the possession of any Tenant, and kept on his farm, within the District, for the aforesaid period—Five Sovereigns.

Class II.

1. For the best Bull, above two and under eight years old, *bona fide* the property, and in possession of any Proprietor or Tenant, in *each* of the eight Districts, Nos. 1, 2, 3, 4, 7, 8, 9, 10, as above described, kept on his farm, within the District, from the 20th day of May preceding the Competition—Ten Sovereigns.

2. For the second best Bull, of the age above specified, *bona fide* the property, and in possession of any Proprietor or Tenant, in *each* of the said eight Districts, and kept on his farm within the District for the aforesaid period—Five Sovereigns.

Class III.

1. For the best two Queys of two years old, the property of, and bred by, any Tenant in *each* of the seven Districts, Nos. 1, 2, 3, 4, 6, 8, 10—Five Sovereigns.

2. For the second best two Queys of two years old, the property of, and bred by, any tenant in *each* of the said seven Districts—Three Sovereigns.

Class IV.

1. For the best two Queys of the West Highland breed, not exceeding three years off, the property of, and bred by, any Tenant in *each* of the three Districts, Nos. 5, 7, and 9—Five Sovereigns.

2 For the second best two Queys of said breed, not exceeding three years off, the property off, and bred by, any Tenant in *each* of thesaid three Districts—Three Sovereigns.

NOTE.—The Society gives the Premiums for three Competitions in alternate years; and provided the gentlemen of the District, or any Local Association therein, shall have continued the Competitions, and have awarded and duly reported Premiums in the District to an amount not less than one-half of the Society's Premiums, and for the same descriptions of Stock, during the two intermediate years, the Society continues its Premiums to the District for an additional year. By this arrangement, each District may have the benefit of six Competitions.

In 1846,

Competitions will take place

In Nos. 1 and 2, for the fourth year, or additional Premiums given by the Society.

Nos. 3, 4, 5 and 6, for the third year of the Society's Premiums.

Nos. 7, 8, and 9, for the first year of the Society's Premiums.

In 1847,

In No. 5, for the fourth, or additional year.

No. 10, for the third year.

NOTE.—Nos. 3, 4, and 6, not having reported intermediate Local Competitions, in terms of the Regulations, are not entitled to the Society's additional Premium in 1847.

FOR THE FIRST DISTRICT—Sir Charles Dalrymple Ferguson, Bart.; in his absence, James Campbell, Esq. of Craigie, to be Convener of the Society's resident Members; five to be a quorum of the Committee.

FOR THE SECOND DISTRICT—Right Hon. the Earl of Seafield; in his Lordship's absence, Colonel Gordon of Park; in absence of both, John Fraser, Esq., Cullen House, to be Convener of the Society's resident Members; five to be a quorum of the Committee.

FOR THE THIRD DISTRICT—Sir George Dunbar of Hempriggs, Bart.; in his absence, James Sinclair, Esq. of Forss, and Robert Innes, Esq. of Thrumster, to be Conveners of the Society's resident Members; three to be a quorum of the Committee.

FOR THE FOURTH DISTRICT—The Duke of Montrose; in his Grace's absence, Alexander Smollett, Esq. of Bonhill, M.P., to be Convener of the Society's resident Members; three to be a quorum of the Committee.

FOR THE FIFTH DISTRICT—The Marquis of Breadalbane; in his Lordship's absence, Dugald Macdougall, Esq. of Gallanach, to be Convener of the Society's resident Members; three to be a quorum.

FOR THE SIXTH DISTRICT—Lord Forbes and Robert Grant, Esq. of

Tilliefour, or either of them, to be Convener of the Society's resident Members; three to be a quorum of the Committee.

For the Seventh District—Francis William Clark, Esq. of Ulva, and Murdoch Maclaine, Esq. of Lochbuy, or either of them, to be Convener of the Society's resident Members; three to be a quorum.

For the Eighth District—Charles Lennox Cumming Bruce, Esq. of Roseisle; in his absence, Robert Grant, Esq. of Kincorth, to be Convener of the Society's resident Members; three to be a quorum.

For the Ninth District—Lord Macdonald and Norman Macleod, Esq. of Macleod, to be Conveners; in their absence, their Factors are authorized to act; three to be a quorum.

For the Tenth District—The Right Hon. Viscount Strathallan; in his Lordship's absence, John Stewart Hepburn, Esq. of Colquhalzie, to be Convener of the Society's resident Members; three to be a quorum.

Blank Reports and Returns of Competitions will be furnished to Conveners of Districts; and it is particularly requested that they may be carefully preserved till required, and accurately and distinctly filled up at the proper time.

RULES OF COMPETITION.

1. The Members of the Society resident in, or connected by property with, the respective Districts, are hereby appointed Committees of Superintendence for regulating the Competitions in their several Districts.

2. With the view of putting preparatory arrangements in train for the Competition, the Convener or Conveners of each District in which the Premiums are this year in competition, will summon by circular letters, or in such other manner as they may think expedient and equally effectual, a Meeting of the Society's Members connected with the Districts, to be held at such time and place as the Convener may appoint, not being later than the 20th of May, for the purpose of fixing the time of competition (and also the place of competition, when not already fixed,) and of naming a Sub-Committee for making all necessary preparatory arrangements for the Show,—including the nomination of Judges, if they propose to call practical judges to their assistance; and of giving due intimation, as after directed, of the time and place of Competition.

3. The Meetings of the Committee of Superintendence, and attendance at competitions for Premiums, to be open to all Members of the Society; and not fewer than the prescribed quorum of the Committee to be present.

4. The Conveners, with the approbation of a quorum of the Committees for conducting the several competitions, are respectively authorized, in such cases as they shall see proper, to divide the two Premiums allowed for Bulls into three Premiums, in such proportions as they shall approve,—the first Premium not being less than Eight Sovereigns; and, in like manner, to divide the sums allowed for Queys into three Premiums, fixing their amount.

5. The Committee shall not place for Competition any Stock which, in their opinion, does not fall within the regulations prescribed, or does not possess merit; and in no instance shall any of the Money Premiums be awarded where there are not, after such selection, at least three Competitors. The Committee are, however, authorized in

any case of deficiency in the required number of Competitors, to make such allowance to a party showing stock of merit, not exceeding half the amount of the Premium, as under the circumstances, they may think reasonable.

6. The times and also the places of Competition are to be fixed by the Conveners, with the advice of at least a quorum of their respective Committees, except in the 5th District, in which Oban is fixed, and in the 8th, in which Elgin and Forres are alternately fixed. The Competitions for the Society's and for the District Premiums are to take place between the 1st of June and 1st of November next.

7. The Conveners will be particularly careful, that the times and places of Competition are intimated throughout their several Districts, two weeks, at least, previously to the days appointed for the Competitions, in such manner as the respective Local Committees shall deem most effectual for communicating the information to all persons interested; and the modes of intimation which may be adopted in the different Districts, as well as the periods of announcement, must be stated in the Reports of the Competitions.

8. The Society does not admit an animal, in any Class of Stock, which may have gained the Society's first Premium at a District or General Show in a former year, to be again shown in Competition in any District; and for no description of Stock shall either the same or a lower denomination of Premium be awarded, in the District in which it has already gained a Premium. In those Districts where the Honorary Silver Medal is offered for Bulls, Tenants cannot compete with the same animal, both for the Honorary and the Money Premiums.

9. No Member of the Committee showing Stock of his own at the Competition shall act as a Judge; nor shall Factors, when they are Members of the Society, and are named on the Committee, or when acting in the absence of Proprietors, be entitled to compete for the Money Premiums in those districts and classes in which Proprietors are excluded from Competition. It is recommended to the Committee to take the assistance of practical men as judges in awarding the Premiums. In all cases, the Bulls for which the Money Premiums are awarded, must have served, or shall be kept to serve, in the District, at least one season; and the rate of service may be fixed by the Committee. The same person is not to obtain more than one of the Premiums for Bulls, and one of the Premiums for Queys, in one year, except in a District where Tenants compete for the Honorary and Money Premiums for Bulls, in which case he may, with different animals, carry the Medal and one of the Money Premiums for Bulls, besides a Premium for Queys. While the Directors have deemed it expedient to exclude Proprietors, and Factors named on the Committee, or acting in the absence of Proprietors, from competing for the *Money Premiums* in certain Districts, where it is apprehended that the superiority of their Stock might discourage competition on the part of the Tenantry, they are fully impressed with the advantages of having such Stock exhibited at the District Shows, and have offered the Honorary Silver Medal of the Society for the best Bull exhibited at the Competition, whether the property of one of the parties aforesaid, or of a Tenant, if superior to the Bull to which the highest Money Premium is awarded. A Bull which, as the property of a Proprietor, a Factor, or a Tenant, may have gained the Honorary Medal, will be allowed to compete, in a future year for the Money Premiums, when, *bona fide*, the property, and in the possession of a Tenant who shall not have been the gainer of the Medal, provided it shall have continued the Winner's property for, at least, one year after the award of the Medal, and shall have afterwards been the Tenant's property, and in his possession from the day fixed by the Regulations—the 20th of May preceding the Competition. A Bull which may have been purchased by two or more tenants, for the use of their Stocks, will be allowed to compete, although the exhibitors may not be joint tenants. Purity of breed is to be taken into account in awarding the Premiums.

10. In order to entitle the Competitors to their respective Premiums, a regular Report, signed by the Convener, and, at least, a majority of the Committee who attend the Competition, must be transmitted by the Convener, so as to be received by the Secretary on or before the 10th of December next, and which Report must certify the following particulars, viz. :—

1. The total number of Bulls and Queys respectively offered for Competition.
2. The number of each admitted to Competition in their appropriate classes, with the number of Competitors in each class.
3. That the Bulls preferred were, *bona fide*, the property of the Competitors, and kept in their possession, or on their farms within the District, from the 20th of May preceding the Competition.
4. The whole periods during which the Bulls have been in their possession.
5. The ages of the Bulls.
6. That the Queys, being two years old, were bred by the Competitors, and were their property on the day of competition.
7. The Names (Christian and surname) and Designations (Estate or Farm, and Parish) of the Persons to whom Premiums were adjudged, and the amount of Premium to each.
8. That due attention has been paid to the rule prescribed for the service of Bulls, for which Money Premiums are awarded.
9. The time and mode of the required previous intimation to the Committee of Judges, and notification to intending Competitors, &c. of the time and place of Competition, given, as directed by the Local Committee; and, in general, the strict observance of all the Rules of Competition, fixed by the Society, as above detailed.

11. Further, it is to be distinctly understood, that in no instance does any claim lie against the Society for expenses attending a Show of Stock, beyond the amount of the Premiums offered.

12. With reference to the Competition in the 5th, 7th, and 9th Districts, the Reports must bear, that the Bulls and Queys preferred were of the West Highland Breed.

13. The Conveners are requested to get the Reports drawn up and signed by a majority of the Committee present at the Competition before they separate, and a certificate of the Competition and Premiums awarded at the intermediate Local Shows in the several Districts, signed by at least two Members of the Society, must be transmitted to the Secretary of the Society, so as to be received by him on or before the 10th December in each year, in order to entitle the Districts to any claim for the additional year's Premiums.

§ II. SHEEP.

1. PREMIUMS FOR IMPROVING THE BREED OF SHEEP.

I. LEICESTER SHEEP.

DISTRICTS.

1. *A District round Cupar in Fife, comprehending Fifeshire, and the contiguous portions of adjoining Counties.*

2. *A District round Ayr, including the low country portions of Ayrshire, Renfrewshire, Lanarkshire, and adjoining Counties.*
3. *A District round Dalkeith, comprehending the Lothians and adjoining parts of Berwickshire.*
4. *A District round Kelso, comprehending Roxburghshire and the lower parts of Berwickshire, commonly termed the Merse, with the Parishes of Mertoun and others to the west.*

PREMIUMS IN EACH OF THE SAID DISTRICTS.

1. For the best Tup of any age, the property of the Competitor, which shall have served in the District the preceding season, or which shall so serve the season following the Exhibition—Ten Sovereigns.

2. For the best three Shearling Tups, the property of the Competitor—Ten Sovereigns.

3. For the best Pen of three Ewes, not less than two Shear, the property of the Competitor—Five Sovereigns.

4. For the best Pen of three Gimmers or Shearling Ewes, the property of the Competitor—Five Sovereigns.

In 1846,

Competitions will take place

In No. 1. For the Fourth Year, or additional Premiums given by the Society.

No. 2. For the Third Year of the Society's Premiums.

No. 3. For the Second Year of the Society's Premiums.

No. 4. For the First Year of the Society's Premiums.

In 1847,

None of the above Districts are in Competition for the Society's Premiums, No. 2. having reported no local competitions in the intermediate years, in terms of the Regulations, has lost right to the additional Premiums.

Local competitions will be held in Nos 3. and 4.

For the First District.—Right Hon. the Earl of Leven and Melville; in his Lordship's absence, Major Anderson of Montrave, to be Convener of the Society's resident Members; five a quorum.

For the Second District.—The Marquis of Bute; in his Lordship's absence, Archibald Hamilton, Esq. of Carcluie, and James Campbell, Esq. of Craigie, Conveners of the Society's resident Members; five a quorum.

FOR THE THIRD DISTRICT.—His Grace the Duke of Buccleuch; in his absence, Robert Scott Moncrieff, Esq., Convener of the Society's resident Members; five a quorum.

FOR THE FOURTH DISTRICT.—His Grace the Duke of Roxburgh; in his Grace's absence, Sir John Pringle of Stitchell, Bart., to be Convener of the Society's resident Members; five a quorum.

II. CHEVIOT SHEEP.

DISTRICTS.

1. *A District round Moffat, comprehending the Pastoral Districts of Dumfriesshire and of the adjoining Counties.*
2. *The District round Hawick.*
3. *The County of Sutherland, and the Parishes of Reay and Latheron, in the County of Caithness.*

PREMIUMS IN EACH OF THE SAID DISTRICTS.

1. For the best Tup of any age, the property of the Competitor, which shall have served in the District the preceding season, or which shall so serve the season following the Competition—Seven Sovereigns.

2. For the best Three Shearling Tups, the property of, and bred by the Competitor—Seven Sovereigns.

3. For the best Pen of Five Ewes, not less than Two Shear, the property of the Competitor—Five Sovereigns.

4. For the best Pen of Five Gimmers or Shearling Ewes, the property of, and bred by the Competitor—Five Sovereigns.

In 1846,

Competitions will take place

In No. 1. For the Fourth Year, or additional Premiums given by the Society.

No. 2. For the Third Year of the Society's Premiums.

No. 3. For the First Year of the Society's Premiums.

In 1847,

No. 2. For the Fourth or additional Premium given by the Society.

No. 3. The Local competition will be held.

FOR THE FIRST DISTRICT.—J. J. Hope Johnstone, Esq. of Annandale M.P.; in his absence, Charles Stewart, Esq., Hillside, to be Convener of the Society's resident Members; five a quorum.

For the Second District.—Allan Elliot Lockhart, Esq. of Cleghorn, to be Convener of the Society's resident Members; three a quorum.

For the Third District.—His Grace the Duke of Sutherland; in his Grace's absence, George Dempster, Esq., of Skibo, to be Convener of the Society's resident Members; three to be a quorum.

III. BLACK-FACED SHEEP.

DISTRICTS.

1. *District of Atholl, including Glenerochy and Strathtummell, and Strathardle, Blackwater and Glenshee, above the Bridge of Calley in the County of Perth.*
2. *The District accessible to Killin, in Breadalbane.*
3. *The District accessible to Lochmaddy, including Barra, the Uists, Benbecula, Harris, and Lewis.*
4. *The Island of Arran.*
5. *A District round Fort-William, comprehending the portions of the Counties of Inverness, Argyle, and Perth, having convenient access to the place of competition.*

PREMIUMS IN EACH OF THE SAID DISTRICTS.

1. For the best Five Tups, not exceeding four Shear, the property of any proprietor, or of any Tenant in the District paying more than £150 of yearly rent—Seven Sovereigns.

2. For the best Five Tups, not exceeding four Shear, the property of any tenant in the District paying not more than £150 of rent—Seven Sovereigns.

3. For the best Pen of Ten Gimmers or Shearling Ewes, belonging to any Proprietor, or to any Tenant in the District paying more than £150 of rent, and which shall be certified at the Competition to have been at least one year in his possession—Five Sovereigns.

4. For the best Pen of Ten Gimmers or Shearling Ewes, under the same condition, but being the property of a Tenant in the District paying not more than £150 of rent—Five Sovereigns.

In 1846,

Competitions will take place

In No. 1. For the Fourth Year, or additional Premium given by the Society.

Nos. 2. and 3. For the Third Year of the Society's Premiums.

No. 4. For the First Year of the Society's Premiums.

In 1847,

No. 2. For the Fourth Year, or additional Premium.

No. 5. For the Third Year of the Society's Premium.

No. 3. Not having reported intermediate local competitions in terms of the Regulations, loses right to the additional Premium.

No. 4. The local competition will be held.

For the First District.—Right Hon. Lord Glenlyon; in his Lordship's absence, P. Small Keir, Esq., of Kinmonth, to be Convener of the Society's resident Members; five a quorum.

For the Second District.—The Marquis of Breadalbane; in his absence, Sir Robert Menzies of Menzies, Bart., to be Convener of the Society's resident Members; five a quorum.

For the Third District.—Colonel Gordon of Cluny; in his absence, Charles Shaw, Esq., to be Convener of the Society's resident Members; three a quorum.

For the Fourth District.—The Most Noble the Marquis of Douglas; in his Lordship's absence, John Paterson, Esq., to be Convener of the Society's resident Members; three a quorum.

For the Fifth District.—The Right Hon. Lord Ward and Colonel Maclean of Ardgour; to be Conveners of the Society's resident Members; three a quorum.

Blank Reports and Returns of Competitions will be furnished to Conveners of Districts; and it is particularly requested that they may be carefully preserved till required, and accurately and distinctly filled up at the proper time.

CONDITIONS AND RULES OF COMPETITION.

1. The Members of the Society in the several Districts are hereby appointed Committees of Superintendence, as in No. 1. of the Regulations for the Cattle Competitions; and they will be convened by their several Conveners on or before the 10th of May, in the same manner and for purposes similar to those indicated in No. 2. of the said Regulations.

2. The Meetings of the Committee of Superintendence, and attendance at Competitions for Premiums, to be open to all Members of the Society; and not fewer than the prescribed quorum of the Committee to be present.

3. It is an express stipulation in regard to the Premiums for Sheep, that the animals produced for Exhibition shall not have been grazed or fed, during the last season, in any way different from the rest of the *same class and age* in the flock to which they belong; and, with the exception of Shearling Ewes, no Ewes shall be allowed to compete but those which have reared Lambs the same season.

4. The boundaries of the Districts are very generally expressed, to enable Competi-

tors to send Sheep to the Exhibition, who are within an attainable distance. The same Sheep, however, cannot draw the Premiums offered in more than one District in the same season.

5. The Competitions in 1846 will take place on such days between the 1st of June and 1st of November as shall be fixed by the Committee.

6. It is recommended to the Committee, as in the case of Cattle Competitions, to take the assistance of practical men as Judges in awarding the Premiums. The Judges, in deciding the Premiums for Sheep, will have regard both to the wool and carcass of the animal. The regulations for Cattle Shows, in regard to the previous intimations to Judges and Competitors—the placing of the stock, and the number of Competitors required for Competition—the power provisionally granted to make an allowance for Stock of merit in the event of deficiency in number, and prohibiting Members acting as Judges who are also Competitors—the regulations relating to extra expenses—and the manner in which the Reports are to be certified and transmitted, are severally hereby declared to be applicable to the Premiums for Sheep.

7. The Society gives these Premiums in alternate years for three Competitions in each District; and provided, during the intervening years, they are continued in the District, and Premiums are awarded by Proprietors or Local Societies, and duly reported to the Society, to an amount not less than one-half of the Society's Premiums, and for the same descriptions of Stock, the Society will continue its Premiums to the District for an additional year, thus affording to the Districts the benefit of six continuous exhibitions.

II. SHEARING SHEEP.

With a view to promote improvement in the Shearing of Sheep, the Silver Medal will be given to the best Sheep-shearer in each of the Districts in which the Society's or local Premiums for Sheep are in operation.

CONDITIONS.

1. Local Associations, or others who propose to claim these Medals, must, on or before the 20th May 1846, lodge with the Society's Secretary a satisfactory guarantee that Money Premiums will be awarded at each Competition to the amount of not less than £2.

2. The District Conveners for the Sheep Premiums, with the aid of their Committees, shall fix the time and place of Competition, and make all necessary arrangements.

3. The Medal shall not be awarded in any case where there are fewer than four Competitors; and it shall always accompany the highest Money Premium. The Sheep shall be divided into lots of six, distinguished by numbers, and the lot to be shorn by each Competitor shall be determined by the number he draws from a set of Tickets marked with corresponding numbers. The whole shall commence on a given signal, a person being appointed to note the time at which each competitor finishes his task. The Judges shall examine each lot in their separate pens; and if two or more lots appear to be equally well executed, preference shall be given to that executed within the shortest time.

4. The Conveners shall report the particulars of the Competition, and the award of the Judges to the Society, along with the Report of the award of the Sheep Premiums in the District.

§ III. SWINE.

PREMIUMS FOR IMPROVING THE BREED OF SWINE.

DISTRICT.

Islands of Orkney.

1. For the best Boar, not under twelve months, and not exceeding four years old, *bona fide* the property, and in possession of any Proprietor or Tenant in the said District, in autumn 1845—Five Sovereigns.

2. For the second best—Three Sovereigns.

3. For the best Breeding Sow of the same age—Four Sovereigns.

4. For the second best—Two Sovereigns.

These Premiums to be awarded for animals that are considered most profitable, and best suited for the purpose of curing mess Pork. Attention is recommended to the introduction of the Berkshire or Suffolk breed of Swine.

It is a condition of the offer of the Premiums that Five Sovereigns shall be contributed by the District.

The Competition will be held at Kirkwall, at such time as the Society's Members resident in the District shall fix, at a meeting to be called by the Convener for the purpose, on or before the 1st of June. This meeting is also authorized to name a Committee for managing all details, and to fix the necessary regulations for competition. A Report of the award of the Premiums, with a copy of the Regulations of Competition, to be transmitted to the Secretary on or before the 10th of December 1846.

Robert Scarth, Esq. of Scarth; in his absence, William Balfour, Esq., Birston Brae, to be Convener.

§ IV. HORSES.

Applications for Premiums for Improving the Breed of Draught Horses will be received for 1847.

CLASS D.

PRODUCTS OF LIVE STOCK.

Applications for Premiums for promoting an improved system of curing Butter and making Cheese, will be received for 1847.

CLASS E.

COTTAGES.

1. PREMIUMS FOR THE BEST KEPT COTTAGES AND GARDENS.

In order to encourage Cottagers to keep their cottages and gardens neat and clean, the following Premiums will be given in the parishes after-mentioned. One-half of the Premiums is given by the Society, and the other half is contributed by the Members, or others, who applied for the Premiums.

Mid-Lothian.

1843.—Parish of Kirkliston.—Convener, James Maitland Hog, Esq. of Newliston.

1843.—Parish of Newton.—Convener, John Wauchope, Esq. of Edmonstone.

1845.—Parish of Penicuick.—Convener, Hugh H. Brown, Esq. of Newhall.

County of Dumfries.

1843.—Parish of Kirkpatrick Juxta.—Convener, J. J. Hope Johnstone, Esq. of Annandale, M.P.

Stewartry of Kirkcudbright.

1844.—Parish of Carsphairn.—Convener, Colonel the Hon. Frederick Macadam Cathcart, of Craigengillan.

1844—Parish of Kells.—Convener, William Grierson Yorstoun, Esq. of Garroch.

1844—Parish of Balmaclellan.—Convener, Walter Dickson, Esq. of Monybuie.

1844—Parish of Crossmichael.—Convener, John Hall, Esq. of Mollance.

County of Berwick.

1844—Parish of Fogo.—Convener, Richard Trotter, Esq. of Mortonhall.

1845—Parish of Polwarth.—Sir H. Hume Campbell, Bart., M.P.

County of Forfar.

1843—Parish of Kettins.—Convener, Robert Pillans Newton, Esq., Hallyburton.

County of Orkney.

1846—Parish of Shapinshay.—Convener, David Balfour, Esq. of Trenabie.

1846—Parish of Stennis.—Convener, David Balfour, Esq. of Trenabie.

1846—Parish of Durness.—Convener, David Balfour, Esq. of Trenabie.

County of Renfrew.

1846—Parish of Erskine.—Convener, John Hall Maxwell, Esq. younger of Dargavel.

1846—Parish of Inchinnan.—Convener, John Henderson, Esq. of Park.

County of Perth.

1846—District of Logie Almond and Glen Almond.—Convener, James Murray Patton, Esq. of Glen Almond.

PREMIUMS.

1. For the best kept Cottage in each of the said Parishes—Two Sovereigns; and in addition, where there shall not be fewer than five Competitors—The Cottage Medal.

2. For the second best kept ditto—One Sovereign.

3. For the best kept Cottage Garden in each parish—One Sovereign.

CONDITIONS.

1. The Cottages may either be single or in villages. The names of intending Competitors may be intimated to the Conveners appointed by the Society, on or before the 20th of June next, and it shall then be competent to the Conveners to add to the list the names of such other individuals as they may think deserving of being brought forward; but after that day, no new name shall be admitted: and in every case, the occupiers of Gentlemen's Lodges, and Gardener's Houses shall be excluded. The inspection of the *Cottages* and *Gardens* to take place between 20th June and 12th September. And, in making the inspection, the Conveners shall have power to take the assistance of any of the Members of the Society, or of any competent judge.

2. In order to authorize the awarding of the Premiums, the annual value of the Cottage of the Competitor, with the ground annexed, must not exceed £5 sterling, and there must, at least, be two Competitors in the District. No Cottage or Garden for which a Premium has been awarded by the Society, will be admitted in competition again for the same or a lower Premium. If the Cottage competing is occupied by the Proprietor, the roof must be in good repair. If the roof is of thatch, it must be in good repair, though in the occupation of a tenant. The windows must be free of broken glass, and perfectly clean, and must afford the means of ventilation. Dunghills, and all other nuisances, must be removed from the front and gables; and the privy, where

there is one, must be kept clean. The peat-stacks, if any, must be so placed as not to be a deformity; and the interior of the Cottage must be as cleanly kept, as the nature of the Cottage admits of. In awarding the Cottage Premiums, the preference will be given to those who, in addition to these requisites, have displayed the greatest taste in ornamenting the exterior of their houses, with the ground in front and at the gables. In the event of there being only one Competitor, it will be in the power of the Committee to award one-half of the Premium, if the merits of the Cottage shall appear to be such as to deserve it.

3. In estimating the claims of Competitors for the Garden Premium, the Judges will have in view—1st, The sufficiency and neatness of the fences; 2d, The cleanness of the ground, and neatness of the walks; 3d, The quality of the crops, and general productiveness of the Garden; and, 4th, The choice of crops. Much advantage is derived in some districts of Scotland, from Cottagers cultivating, besides the more common crops, a portion of early potatoes along with the late, of early cabbage, early pease, cauliflower, lettuce, with some gooseberry and currant bushes, and a fruit-tree trained against the wall, &c.

4. Reports, stating that the various particulars before mentioned have been attended to, the number of Competitors, the names of the successful parties, and the nature of the exertions which have been made by them, must be transmitted by the Conveners to the Secretary of the Society, on or before the 10th day of October next.

5. The Premiums are given for four successive years in each parish. In any parish where the Convener may think it unnecessary to continue them for so long a period, he is requested to state this in his annual Report, and the Directors will be guided by his recommendation. When the Convener shall neglect to make a Report, or to assign a satisfactory reason for there being no Competition, the name of the parish shall in the following year be struck off the list.

6. Similar Premiums will be given, for four successive years, to as many additional parishes, according to priority of application, as will make, with those already on the list, the whole number of the competing parishes thirty-two, on condition that a satisfactory guarantee for one-half of the amount of the Premiums to be given, shall be lodged by each parish with the Secretary, on or before the 1st of January 1847.

2. BEE HUSBANDRY.

If any of the above mentioned parishes shall wish to have a Premium instituted for promoting the cultivation of Bees among the peasantry, Ten Shillings will be granted annually for that purpose from the funds of the Society, also for a period of four years, on a guarantee for the like amount being received from the parish making the application. The conditions of competition will be arranged hereafter. The Competitor will be preferred who shall, in the course of the season, have raised the greatest number of hives of Bees, not under four, from stocks, whether the property of the Competitor or belonging to others. If the numbers are equal, the preference will be given to those which have been best managed.

3. MEDALS TO COTTAGERS.

In the view of giving still farther encouragement to Cottagers of

the description referred to under the first branch of this Class, who do not reside in Parishes in which the regular Premiums are in operation, and at the same time of aiding Local Associations and public-spirited individuals, who, at their own expense, establish Premiums for the like objects, the Society will give its Cottage Medal to such Associations or individuals as apply for it. The number of Medals to be issued annually is limited to twelve.

Application for these Medals, stating the amount of the Premiums given by the parties applying, must be made to the Society on or before the 1st of July in each year. The Medals will afterwards be issued upon a Report, certified in the terms required by the preceding conditions, describing the merits of the Cottagers. The Reports to be lodged with the Secretary before the 10th November of the year in which the application is made.

4. PREMIUMS TO PROPRIETORS FOR BUILDING AND IMPROVING COTTAGES.

1. *The County of Haddington.*
2. *The County of Inverness.*

In order to mark the sense which the Society entertains of the advantages likely to result to the country, by Landed Proprietors exerting themselves to improve the style and comfort of Cottages on their estates; and in order to call the attention of such Proprietors to the subject, the Society proposes to give the following Premiums:—

1. FOR BUILDING COTTAGES.

1. To the Proprietor in each of the said Districts who shall have erected on his estate, during the years 1845 or 1846, the best approved Cottage—The Honorary Silver Medal.

2. To the Proprietor in each of the said Districts who shall have erected on his estate, during the years 1843, 44, 45, and 1846, the greatest number of approved Cottages—The Gold Medal.

2. FOR IMPROVING EXISTING COTTAGES.

3. To the Proprietor in each of the said Districts who shall have improved and enlarged, where necessary, during the years 1844, 1845, and 1846, the greatest number of his existing Cottages—The Gold Medal.

Any District.

4. To the Proprietor in any District in Scotland who shall have

improved and enlarged where necessary, during the years 1845, 1846, and 1847, five or more of his existing Cottages—The Gold Medal.

The claims of intending Competitors for the Premium, No. 1, must be lodged with the Conveners of the Committee of the Society in the said Counties, on or before the 1st of October in the year in which the claims are made, otherwise they will not be entitled to compete; those for the Premiums Nos. 2 and 3 in the same manner, on or before the 1st of October 1846; and those for the Premium No. 4, in the same manner, on or before the 10th of October 1847. The inspection of the Cottages to take place between the 1st October and the 1st November in the year in which the claim is made, for the Premium No. 1; between the same dates in the year 1846 for the Premiums Nos. 2 and 3; and between the same dates in the year 1847, for the Premium No. 4.

Reports by the Conveners to be transmitted to the Secretary of the Society on or before the 30th November in each year.

In order to authorize the award of the Premiums, the annual value of the Cottage or Cottages separately, with garden-ground, must not exceed £5, and in awarding the Premium No. 2, the Cottage for which the Premium No. 1 has been awarded, shall be deducted from the number.

In estimating the claims of Competitors, the following points will be kept in view.—1st, The situation of the Cottage with reference to amenity of climate and aspect, and to the means of drainage, ventilation, and of preserving cleanliness. 2d, The suitableness of the structure to withstand the effects of the climate of the District. 3d, The accommodation in the interior of the Cottage, and the arrangement of the out-houses, more especially of the privy and ash-pit, which must be as much as possible out of sight, and screened by a few trees or shrubs. No Cottage without a privy to be entered for Competition. 4th, The small expense of the building, &c., compared with its durability, and with the accommodation afforded, and calculated with reference to the price of materials, and other circumstances, which may vary in different Districts. 5th, The outward appearance of the Cottage or Cottages. When it appears that the Cottages of one Competitor are superior in point of style and comfort to those of another, though not so numerous, the Inspectors to give the preference to the former, provided that they amount at least to the number of five, and have been erected at a moderate expense.

Parties competing to forward plans, specifications, and estimates, to the Society, through the Conveners of the Districts, from which, and of all information sent therewith, copies may be taken for publication,

if the Society shall see fit, and the originals returned to the parties within six months, if desired.

The Members of the Society in the respective Counties, or in the neighbourhood of the Cottages competing, are appointed Committees to inspect the Cottages, and report on the claims, with power to name Sub-Committees.

For the First District.—Sir George Grant Suttie, Bart. of Prestongrange, to be Convener.

For the Second District.—James M. Grant, Esq. of Glenmoriston, and John Stewart, Esq. of Belladrum, to be Conveners.

5. USE OF THE SPADE.

The Society, with the view of promoting dexterity in the use of the Spade, will give the following Premiums in the parishes aftermentioned, viz.—

Dumfriesshire.

1844—Parish of Canobie.—Convener, George Scott Elliot, Esq. Larriston.

Perthshire.

1844—Parish of Redgorton.—Convener, Robert Graham, Esq. of Balgowan.

PREMIUMS.

For the best specimen of Spade Work in each of these Parishes, at a competition between not fewer than twelve Competitors—the sum of £1, 5s.

For the second best, 15s.

For the third best, 10s.; And 30s. will be at the disposal of the Convener and Committee, for division among the unsuccessful Competitors.

CONDITIONS.

At least one month before the day of Competition, the time and place of competition, the quantity of ground to be turned over by each Competitor, the depth to which it is to be dug, the manner in which the spits are to be laid, and the time to be allowed for the performance of the work, (which, in all cases, care will be taken shall be ample,) shall be fixed and declared by the Convener; and, where practicable, the Convener shall, by the same time, have dug, in a central situation, a piece of ground affording a sufficient specimen of the manner in which the work is to be performed, which is to be done by the spade only, and not by the shovel. The Convener shall decide the Premiums, with the assistance of such other members of the Society as may attend. Failing the attendance of more than one Member, the assistance of competent judges to be taken. In case of perfect equality, the preference to be given to the Lot which is first finished. Gardeners, and persons who have gained first Premiums, to be ex-

cluded from Competing. The Competitions must take place on or before the 11th of November next, and be reported to the Secretary of the Society on or before the 1st December following. Any parish failing to report within the time specified, shall forfeit the benefit of the Premiums in future years.

The like Premiums will be given in four additional parishes in the year 1847, and three succeeding years, on guarantees to the amount of half of the Premiums offered being lodged with the Secretary by the parties making the application, on or before the 1st of January next.

NOTE.—These Premiums are proposed chiefly for the benefit of Districts in which there is a redundant population.

In order that the Premiums offered may be made known to the industrious Cottagers, the Society trusts much to the obliging co-operation of the Clergy in the Counties in which the Cottage Premiums are offered.

THE GENERAL SHOW OF LIVE STOCK,

AND

AGRICULTURAL MEETING AT INVERNESS IN 1846.

The Society having resolved to hold the General Show of Live Stock, and the Agricultural Meeting for 1846 at INVERNESS, the following Premiums will then be awarded, aided by donations from Noblemen, Gentlemen, and Local Agricultural Associations of the Counties more immediately interested, and from the Town of Inverness.

The Competition is open to Stock from every part of the United Kingdom. The Show will take place on the 25th, 26th, and 27th of August.

The arrangements will be :—

TUESDAY, 25th August.—The Exhibition of Agricultural Implements, Dairy Produce, Roots, Seeds, and Plants.

WEDNESDAY, 26th August.—The General Show of Cattle, Horses, Sheep, Swine, and the whole of the articles enumerated above, Exhibited on Tuesday.

THURSDAY, 27th August.—The Exhibition of the Prize Stock, Implements, and other articles.

CLASS I. CATTLE.

WEST HIGHLAND BREED.

Section I. For the best Bull, calved between 1st January 1840 and 1st January 1844—Twenty Sovereigns.

For the second best ditto—Ten Sovereigns.

To the *Breeder* of the best Bull in this Section—The Honorary Silver Medal.

> It is a Condition attached to the Premiums in this Section, that the Exhibitors shall be obliged to let out, in the season 1847, the Prize Bulls, to serve at least forty cows, at such places in the Districts more immediately connected with the Show, as the Committee shall fix, on payment of Five Shillings for each cow. The owner, if resident within the District, to have preference of service for his own Stock.

II. For the best Bull, calved after 1st January 1844—Seven Sovereigns.

III. For the best breeding Cow, not exceeding eight years old, which has reared a Calf during the season of the Show. The Calf to be shown—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

For the third best ditto—Three Sovereigns.

IV. For the best three Cows reared and bred by the Exhibitor, which have had calves during the season of the Show, with their Calves at their feet—Fifteen Sovereigns.

V. For the best two Heifers, calved after 1st January 1843—Ten Sovereigns.

For the second best two ditto—Five Sovereigns.

VI. For the best two Heifers, calved after 1st January 1844—Seven Sovereigns.

For the second best two ditto—Three Sovereigns.

VII. For the best two Oxen, calved after 1st January 1842—Ten Sovereigns.

VIII. For the best two Oxen, calved after 1st January 1843—Seven Sovereigns.

IX. For the best two Oxen, calved after 1st January 1843, which have never been housed nor confined in the straw-yard since Whitsunday 1844—Seven Sovereigns.

X. For the best two Oxen, calved after 1st January 1844—Five Sovereigns.

XI. For the best lot of Stot Stirks, not fewer than *six*, calved after 1st January 1845, bred by the Exhibitor—Seven Sovereigns.

XII. For the best lot of six Queys, calved after 1st January 1845, bred by the Exhibitor—Seven Sovereigns.

SHORT HORNED BREED.

XIII. For the best Bull, calved between 1st January 1840, and 1st January 1845—Twenty Sovereigns.

For the second best ditto.—Ten Sovereigns.

To the *Breeder* of the best Bull in this Section—The Honorary Silver Medal.

XIV. For the best Bull Stirk, calved after 1st January 1845—Ten Sovereigns.

For the second best ditto—Seven Sovereigns.

XV. For the best breeding Cow, of any age, having reared a Calf during the season of the Show—Ten Sovereigns.

For the second best ditto—Seven Sovereigns.

XVI. For the best Heifer, calved after 1st January 1844—Seven Sovereigns.

XVII. For the best two Heifers, calved after 1st January 1845—Five Sovereigns.

XVIII. For the best pair of Oxen, calved after 1st January 1843—Ten Sovereigns.

XIX. For the best pair of Oxen, calved after 1st January 1844—Ten Sovereigns.

ABERDEEN, ANGUS, AND GALLOWAY POLLED BREEDS.

XX. For the best Bull, calved between 1st January 1839 and 1st January 1844—Twenty Sovereigns.

For the second best ditto—Ten Sovereigns.

To the *Breeder* of the best Bull in this Section—The Honorary Silver Medal.

XXI. For the best Bull, calved after 1st January 1844—Ten Sovereigns.

XXII. For the best Cow, calved previous to 1st January 1843, having reared a Calf during the season of the Show—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

XXIII. For the best two Heifers, calved after 1st January 1843—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

XXIV. For the best two Heifers, calved after 1st January 1844—Seven Sovereigns.

For the second best ditto—Three Sovereigns.

XXV. For the best two Oxen, calved after 1st January 1842—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

XXVI. For the best pair of Oxen, calved after 1st January 1843—Ten Sovereigns.

XXVII. For the best pair of Oxen, calved after 1st January 1844—Seven Sovereigns.

ABERDEENSHIRE HORNED BREED.

XXVIII. For the best Bull, calved between 1st January 1839 and 1st January 1844—Fifteen Sovereigns.

To the *Breeder* of the best Bull in this Section—The Honorary Silver Medal.

XXIX. For the best Bull, calved after 1st January 1844—Ten Sovereigns.

XXX. For the best Cow, calved previous to 1st January 1843, having reared a calf during the season of the Show—Seven Sovereigns.

For the second best ditto—Five Sovereigns.

XXXI. For the best Heifer, calved after 1st January 1844—Five Sovereigns.

AYRSHIRE BREED.

XXXII. For the best Bull, calved after 1st January 1842—Fifteen Sovereigns.

To the *Breeder* of the best Bull in this Section—The Honorary Silver Medal.

XXXIII. For the best Bull, calved after 1st January 1844—Ten Sovereigns.

XXXIV. For the best Cow in Milk—Seven Sovereigns.

For the second best ditto—Five Sovereigns.

XXXV. For the best Heifer, calved after 1st January 1844—Five Sovereigns.

For the second best ditto—Three Sovereigns.

ANY BREED.

XXXVI. For the best pair of fat Oxen, of any pure breed, except Short Horn, calved after 1st January 1842—Ten Sovereigns.

CROSSES.

XXXVII. For the best two Oxen, calved after 1st January 1842, a cross between a Short-horned Bull and a West Highland Cow—Eight Sovereigns.

XXXVIII. For the best two Oxen, calved after 1st January, 1842, a cross between a Short-horned Bull and Ayrshire Cow—Eight Sovereigns.

XXXIX. For the best two Oxen, calved after 1st January 1842, a cross between a Short-horned Bull and a Pure Cow of any breed except the West Highland or Ayrshire—Eight Sovereigns.

XL. For the best two Oxen, calved after 1st January 1843, a cross between a Short-horned Bull and West Highland Cow—Eight Sovereigns.

XLI. For the best two Oxen, calved after 1st January 1843, a cross between a Short-horned Bull and Ayrshire Cow—Eight Sovereigns.

XLII. For the best two Oxen, calved after 1st January 1843, a cross between a Short-horned Bull and a pure Cow of any breed except the West Highland or Ayrshire—Eight Sovereigns.

XLIII. For the best two Oxen of any cross, calved after 1st January 1842—Eight Sovereigns.

CLASS II. HORSES.

Section I. For the best entire Horse, for Agricultural purposes, not under four years, and not exceeding eight and a half years old, bringing evidence of having had produce in the former year—Thirty Sovereigns.

For the second best ditto—Twenty-five Sovereigns.

For the third best ditto—Twenty Sovereigns.

It is a Condition attached to the Premiums in this Section, that the Exhibitors shall be obliged to let out the Prize Horses, for season 1847, to serve within such portion, and at such places of the Districts as the Local Committee may fix. The number of Mares to be

served by each Horse, not to exceed seventy, and the charge to be One Sovereign for each Mare.

II. For the best entire Colt for Agricultural purposes, not exceeding three years and six months old—Ten Sovereigns.

III. For the best Breeding Mare, for Agricultural purposes, having had at least one Foal, and having been at least one year in the possession of the Competitor—Ten Sovereigns.

For the second best ditto—Seven Sovereigns.

IV. For the best three-year-old Filly, for Agricultural purposes—Seven Sovereigns.

For the second best ditto—Five Sovereigns.

V. For the best two-year-old Filly, for Agricultural purposes—Five Sovereigns.

For the second best ditto—Three Sovereigns.

VI. For the best four-year-old Draught Gelding—Three Sovereigns.

VII. For the best three-year-old Draught Gelding—Three Sovereigns.

SADDLE PONIES.

VIII. For the best Highland entire Pony, not exceeding fourteen hands high—Ten Sovereigns.

IX. For the best Highland Breeding Pony Mare of the same height—Seven Sovereigns.

X. For the best Pony Gelding not more than four years old, and not exceeding fourteen hands high—Five Sovereigns.

CLASS III. SHEEP.

BLACK-FACED BREED.

SECTION I. For the best two Tups, not exceeding forty-five months old, which shall have served a hirsel of Ewes in 1845—Seven Sovereigns.

For the second best two ditto—Five Sovereigns.

II. For the best pen of five Ewes, not exceeding five years and seven months old, selected from a hirsel of a regular breeding stock, not less than 200, and the pen having reared Lambs for the season—Seven Sovereigns.

For the second best pen of five ditto—Five Sovereigns.

III. For the best five Gimmers, selected from a hirsel not less than

200, and kept with the others of that age up to 1st June previous to the Show—Five Sovereigns.

IV. For the best pen of five Wethers, not exceeding five years and seven months old—Five Sovereigns.

V. For the best pen of five Wethers of any age, fed without restriction—Five Sovereigns.

CHEVIOT BREED.

VI. For the best two Tups, not exceeding forty-five months old, and which shall have served with a hirsel for a period of not less than one month in 1845—Ten Sovereigns.

For the second best two ditto—Seven Sovereigns.

VII. For the best two Shearling Tups—Seven Sovereigns.

For the second best two ditto—Five Sovereigns.

VIII. For the best Tup of any age, which has served with a hirsel for a period of not less than a month in 1845 — Seven Sovereigns.

IX. For the best pen of five Ewes, not exceeding five years, and which have reared Lambs for the season 1846—Seven Sovereigns.

For the second best pen of five ditto—Five Sovereigns.

X. For the best pen of five Ewes, lambed after the 31st March 1844—Seven Sovereigns.

For the second best pen of five ditto—Five Sovereigns.

XI. For the best pen of five Gimmers—Seven Sovereigns.

For the second best pen of five ditto—Five Sovereigns.

XII. For the best pen of five four-year-old Wethers, showing most symmetry, fat, and weight—Five Sovereigns.

For the second best pen of five ditto—Three Sovereigns.

XIII. For the best pen of five three-year-old Wethers, showing most symmetry, fat, and weight—Five Sovereigns.

XIV. For the best pen of five Wethers of any age, showing most symmetry, fat, and weight, fed without restriction — Five Sovereigns.

For the second best pen of five ditto—Three Sovereigns.

XV. For the best pen of five Ewes, lambed after the 31st March 1844, fed at no time, except on natural pasture, for the last twelve months prior to the Show—Five Sovereigns.

XVI. For the best pen of five Gimmers, fed at no time, except on natural pasture, for the last twelve months prior to the Show—Five Sovereigns.

LEICESTER BREED.

XVII. For the best Tup not exceeding forty-five months old—Seven Sovereigns.

For the second best ditto—Five Sovereigns.

XVIII. For the best Shearling Tup—Five Sovereigns.

For the second best ditto—Three Sovereigns.

XIX. For the best pen of three Ewes of any age—Five Sovereigns.

For the second best pen of three ditto—Three Sovereigns.

XX. For the best pen of three Shearling Ewes—Five Sovereigns.

For the second best pen of three ditto—Three Sovereigns.

SOUTHDOWN BREED.

XXI.—For the best Tup not exceeding four years old—Five Sovereigns.

XXII. For the best pen of three Ewes—Five Sovereigns.

CROSSES.

XXIII. For the best pen of five fat Wethers, a cross between Leicester Tups and Cheviot Ewes, not exceeding three years and eight months old—Five Sovereigns.

XXIV. For the best pen of five fat Wethers, a cross between Leicester Tups and Cheviot Ewes, not exceeding two years and eight months old—Five Sovereigns.

XXV. For the best pen of five fat Wethers, a cross between Leicester Tups and Black-faced Ewes, not exceeding three years and eight months old—Five Sovereigns.

XXVI. For the best pen of five fat Wethers, cross between Cheviot Tups and Black-faced Ewes, not exceeding three years and eight months old—Five Sovereigns.

CLASS IV. SWINE.

SECTION I. For the best Boar, large breed—Four Sovereigns.

For the second best ditto—Two Sovereigns.

II. For the best Boar, small breed—Four Sovereigns.

For the second best ditto—Two Sovereigns.

III. For the best Sow, large breed, in pig or milk—Four Sovereigns.

For the second best ditto—Two Sovereigns.

IV. For the best Sow, small breed, in pig or milk—Four Sovereigns.

For the second best ditto—Two Sovereigns.

V. For the best three Store Pigs of the same litter, from four to nine months old—Three Sovereigns.

For the second best ditto—Two Sovereigns.

CLASS V. POULTRY.

Section I. For the best couple of Turkeys of any breed—One Sovereign.

For the second best ditto—Ten Shillings.

II. For the best couple of Fowls of the Dorking breed—One Sovereign.

For the second best ditto—Ten Shillings.

III. For the best couple of any other Fowls of pure breed—One Sovereign.

For the second best ditto—Ten Shillings.

IV. For the best couple of Ducks of any breed—One Sovereign.

For the second best ditto—Ten Shillings.

V. For the best couple of Geese of any breed—One Sovereign.

For the second best ditto—Ten Shillings.

N.B.—By the word "couple" is meant a male and female of each sort.

CLASS VI.—DAIRY PRODUCE.

I. CURING BUTTER.

Section I. To the owner of any Dairy who shall have made and cured for keeping through the season, the best quality of Butter for the market, not being less than two cwt. in 1846—Five Sovereigns.

For the second best quality of ditto—Three Sovereigns.

II. MAKING CHEESE.

II. To the person who shall produce the best specimen of Sweet or Full Milk Cheese, made of any variety that he finds most profitable for the market—Five Sovereigns.

For the second best ditto—Three Sovereigns.

The quantity of the variety of Cheese produced made by each Competitor, must not be less than one cwt.; and it must be certified that the two or more Cheeses shown have not been stated, and that, in

the belief of the Exhibitor, they are a fair average sample of the kind competing, made during the year by the Competitor.

III. To the owner of any Dairy who shall have made for sale, during the season 1846, the best quality of Cheese from Skimmed Milk, not being less than one cwt.— Five Sovereigns.

For the second best ditto.—Three Sovereigns.

The Milk for the Skimmed Milk Cheese must have stood at least twenty-four hours before being skimmed.

In the event of two or more competing lots of Butter or Cheese being deemed equal in quality, the Premium will be awarded to the greatest quantity made.

CLASS VII. EXTRA STOCK—ROOTS AND SEEDS.

For Extra Stock of any kind not shown for any of the above Premiums, and not exceeding in one lot five Cattle or ten Sheep, and for Roots, Seeds, &c., Premiums will be awarded in Money, Plate, or Honorary Medals,—to the amount of Fifty Sovereigns.

CLASS VIII. IMPLEMENTS.

Section I. For any New and Useful Agricultural Implement or Machine that has been satisfactorily tested in actual work—Five Sovereigns.

II. For the Subsoil Plough best suited to accomplish the main objects of Subsoil Ploughing, viz., moving, breaking, stirring, and effectually detaching the Subsoil from its own substratum, without bringing it to the surface—Five Sovereigns.

III. For the best Subsoil Grubber—Three Sovereigns.

IV. For the best Two Horse Plough, either of Wood or Iron construction; workmanship, ease of draught, and effects in lifting and turning over the furrow, being all considered—Five Sovereigns.

V. For the best Winnowing Machine or Barn Fanner—Four Sovereigns.

VI. For the best Single-Horse Cart, with Wheels and Axle, adapted to Farm purposes—Five Sovereigns.

VII. For the best Implement of any kind used in the cultivation of the Turnip or Potato crop—Five Sovereigns.

VIII. Fo any useful improvement in any of the Utensils used in Dairy Husbandry—Four Sovereigns.

IX. For the best set of Models, or of Specimens of any Improved, Certain, and Economical Method of Constructing Drains, for the Drainage of Land, whether by means of Tiles or Pipes of burnt clay, of Peat Moss, Wood, or Stone, or any combination of these—Five Sovereigns.

X. For the best set of Apparatus, either of full size or in model, for Dipping or Bathing Sheep—Three Sovereigns.

XI. For a Model for the Effectual Washing of Sheep, with Short Description of the Mode of Conducting the process—Three Sovereigns.

XII. For the best set of Cart and Plough Harness—Three Sovereigns.

XIII. Premiums in Money and in Medals will be awarded for approved patented articles, and for articles not embraced in any of the foregoing Sections—to an amount not exceeding Twenty Sovereigns. This Section will comprehend Implements and Utensils of all descriptions used for farm purposes, together with Utensils employed in any other rural occupation, such as Draining, Quarrying, Road Making, &c.

1. It will be allowable for the Judges to exercise their discretion in awarding the whole amount assigned to a section, either in one or more premiums, according to the claims of competitors; and, while awards are not to be made without positive merit in the articles exhibited, it is to be understood, that any sum which may be unappropriated in one section may, if considered proper, be applied to another section.
2. It is desirable that paint should not be used upon the wood or iron-work of the implements or machines exhibited, but they may be coated with transparent varnish. Exhibitors must be prepared, if required by the Judges, to separate the parts of implements or machines, and must come provided with instruments for that purpose.
3. Competitors are required to furnish to the Secretary of the Society, on or before the 7th of August, descriptive Lists of the Implements or machines intended for exhibition.

GENERAL REGULATIONS.

1. The Stock must, at the date of the Competition, be *bona fide* the property and in the possession of the party in whose name it is entered, and it must have been so at least from the 1st of May 1846.

2. The ages of the Stock will be calculated from the 1st of January of the year of birth. Where the precise age is known, it is to be stated.

3. Cattle fed on distillery or brewers' wash, or grains, are excluded from Competi-

tion, as that food is not generally accessible. Stock which may have received oil-cake or grain is not excluded; but where cake or grain has been used, the quantities are to be stated in the certificate.

4. Cows in Competition must have had a calf, or be in calf; and Ewes must have reared lambs in the year 1846. If desired, evidence must be produced that Stallions and Bulls, if four years old or upwards, for which Premiums may be awarded, had produce in the preceding year. The Ewes must form part of regular breeding stocks.

5. Sheep in Competition, excepting in Sections V and XIV, must not have been grazed or fed during the season preceding the Show, in any way different from the other sheep of the *same class and age* in the flock to which they belong. No sheep must have been clipped earlier, or otherwise, than the remainder of the Stock of the same description from which they are taken.

6. An animal having already gained a first Premium at any of the Society's General Shows, is not to be shown again in competition in a class of the same denomination. If shown as Extra Stock, the Exhibitor will be eligible to receive the Society's Silver Medal.

7. The Stock to be shown must be intimated by a certificate for each lot, according to the forms hereto annexed. It shall be competent to the Committee, if they see fit to require the Exhibitor, or the person in charge of the Stock, to confirm the Certificate in the presence of a Magistrate, on the day of Competition. Printed Certificates, to be completed with the required particulars, and to be subscribed by the Exhibitor, may be had on application at the Society's Hall, Edinburgh, and at the office, in Inverness, of George Anderson, Esq., Secretary to the Local Committee.

The Secretary will be at Inverness on the 5th of August, to answer inquiries, attend to details, and to receive certificates. In the meantime, Certificates may be lodged with him at Edinburgh, or with the Local Secretary at Inverness.

The Certificates, duly completed, must be lodged with the Secretary of the Society, or transmitted, so as to reach his office in Albyn Place, Edinburgh, or the Local Secretary at Inverness, at the latest by the 7th of August. The Certificates, when lodged, are not to be divulged, except by direction of the Committee. A Competitor may show more than one lot in any Section, but not more than three lots. It shall not be competent to enter a lot in one Section, and to withdraw it for competition in another, except by authority of the Committee. The same lot of Stock can be entered in one Section only.

8. Besides the Stock specified in the Sections of the above list, Cattle, Horses, Sheep and Swine, possessed of merit, may be exhibited as Extra Stock, if duly intimated by a Certificate for each lot, in a form similar to what is prescribed for the Competing Sections, and lodged on or before the 7th August. If any lot of Fat Stock, for which a competing Section is open, is to be entered as Extra Stock, from an impression on the part of the Exhibitor that the animals are too young to compete successfully in the Section open to them, the Judges of Extra Stock are directed to notice them specially, provided they possess merit. Dairy Produce, Poultry, Seeds, Roots, Plants, &c., must also be intimated, by lodging with the Secretary, on or before the 7th August, Certificates of the articles, as above mentioned.

9. A responsible person must attend at the Secretary's office in Inverness, not later than the 20th August, to give explanations, if required, to receive instructions, and, if not previously issued, orders duly signed for the admission of the Stock to the Show-ground. The person so attending must be acquainted with the various particulars required to be certified.

10. A list of the Stock and articles entered on or before the 7th August will be immediately made up by the Secretary, and none will be allowed to compete which are not entered in that list.

11. All Stock and other articles entered, must be brought forward to the Competition, unless prevented by some unavoidable cause. If not so brought forward, the owner will, if a reason, satisfactory to the Chairman of the Committee or to the Directors, is not assigned, be liable for all expenses caused by the entry. The Implements and Machines, Seeds, Roots, Plants, and Dairy Produce, must be brought to the Show-ground, by nine o'clock in the morning of Tuesday the 25th August. The Stock must be brought to the Show-ground between the hours of six and eight o'clock of the morning of Wednesday the 26th August, to afford time for placing them. No Stock or other articles can come within the premises, without having an admission order. One servant only for each lot can be admitted, and he must continue in charge of the lot in the Show-yard. Bulls must be secured by a ring or screw in the nose, with a chain or rope attached; otherwise they will not be admitted into the Show-yard. The Competing Stock will be distinguished by *numbers*, so that the owner's name will not be known until the Premiums are decided.

12. The arrangements for the Show will be conducted by a Committee of the Society's Members. Skilful persons will be appointed to act as Judges, who will be divided into sections, to judge of the Classes with which they are best acquainted, in order to render the inspection as short as possible, and that the public may have early access to the Show-ground. The Judges, in forming their opinion, will particularly attend to the instructions hereto annexed.

13. A member of the Committee, or of the deputation of Directors, will be appointed to attend each section of the Judges. A servant, provided with tickets, upon which shall be printed the Premium to be awarded, will be in attendance on the Member so appointed; and as soon as a section of the Judges shall determine which animal or animals are entitled to the Prizes in their respective Sections, the Member of the Committee or deputation of Directors shall order the servant to affix the Prize Tickets on the animal, and the Member is to be responsible for the Tickets being affixed accordingly, that the public may have the earliest opportunity to examine the points of the Prize Cattle. None of the Tickets so placed shall be removed. If any Prize Ticket be removed, and affixed to an animal which has not obtained a Premium, the parties so offending shall be proceeded against as the Committee of Directors may appoint. On Wednesday, the Stock shall be withdrawn, and the Show-yard shut at four o'clock.

14. All the *Prize* Animals shall be brought to the Show-Ground by ten o'clock in the morning of the day immediately after the General Show, (viz. on Thursday,) under penalty of the owner forfeiting the Premiums. The Deputation of the Directors will then determine if Portraits of any of the Prize Animals shall be taken for the Society's Museum, and, in the event of any being selected, the owners are required to keep them in, or near the town, for such a reasonable time, as may be necessary to take the Portrait, under the penalty of forfeiting the Premium. The expense attending the detention, which will be limited to four days, to be paid to the owner by the Society, at a rate not exceeding 7s. 6d. per day. Exhibitors who may have Stock possessing particular merit, especially such animals as have been commended by the Judges, are invited to show them on this day, for the gratification of practical Breeders, when a favourable opportunity may be given to sell both Breeding and Fat Stock to advantage. The Premiums will be paid with the Society's General Premiums, on or after the 10th of February 1847.

15. No change can, under any circumstances, be made upon the General Regulations established by the Society for Agricultural Meetings and General Shows of Live Stock, so far as Competitors are interested, unless regularly submitted and approved at a Meeting of the Directors in Edinburgh, and duly intimated to Competitors.

His Grace the DUKE of MONTROSE, President, and the Vice-Presidents of the Society; the Lord-Lieutenants, Vice-Lieutenants, and Conveners of the Counties of

Inverness, Ross, Cromarty, Caithness, Sutherland, Elgin, and Nairn, with an adequate number of the Members of the Society, to be named at the Meetings on the 30th of April by these Counties, together with the Secretaries of the Local Agricultural Associations in the said Counties, have been appointed a Committee for regulating all details connected with the Agricultural Meeting, and General Show of Live Stock at Inverness. John Macpherson Grant, Esq., yr. of Ballindalloch, to be Chairman and Convener, and George Anderson, Esq., Inverness, Secretary of the Committee.

FORM OF CERTIFICATE FOR FAT OXEN.

I, , near the post town of , in the county of , do certify, That my Ox (or Oxen, as the case may be) of the breed, to be shown at the General Show of Live Stock at Inverness, for the premium in Section was bred by Mr. of , and purchased by me from on or about ; he was calved , and will, at the date of the Show, be years and months old, and has been fed by me on . The quantity of cake or corn he has consumed has been . He has not at any time been fed on distillery or brewers' wash or grains. He will have to travel on foot (or by steam, or other conveyance, as the case may be) miles, or thereby, from the place of feeding to the Show at Inverness. He was first put up to fatten on or about the day of . Witness my hand this day of 1846.

(Signature of the Exhibitor.)

N.B. Any observations as to the animal's appearance and state of flesh when put up to feed, or other particulars which the Exhibitor may think material, and more especially the pedigree, may be subjoined to the above certificate.

FORM OF CERTIFICATE FOR CATTLE—LEAN OR BREEDING STOCK.

I, of , near , in the county of , do certify, That my of the breed, to be shown at the General Show of Live Stock at Inverness, for the Premium in Section bred by , and purchased by me from , on or about , and calved , will, at the date of the Show, be years and months old, and since been in my possession, food been ; will have to travel on foot miles or thereby, to the Show at Inverness. Witness my hand this day of 1846.

(Signature of the Exhibitor.)

N.B.—Any observations with reference to other particulars, which the Exhibitor may think material, may be subjoined to the above certificate. The pedigree, when known, must also be stated.

FORM OF CERTIFICATE FOR HORSES, SHEEP, OR SWINE.

I, of , near , in the county of , do certify, That my of the breed, to be shown at the General Show of Live Stock at Inverness, for the Premium in Section , bred by , and purchased by me from , foaled (lambed or pigged, as the case may be) , will, at the date of the Show, be years and months old, and since been in my possession, food been ; will have to travel on foot miles or thereby, to the Show at Inverness. Witness my hand this day of 1846.

(Signature of the Exhibitor.)

N.B.—Any observations with reference to other particulars, which the Exhibitor may think material, may be subjoined to the above certificate. The pedigree, when known, must also be stated.

INSTRUCTIONS TO THE JUDGES.

1. The Judges will assemble on the morning of the Show, at the time and place to be appointed by the Committee. When it is intimated that the Stock is ready to be examined, the Judges will proceed to the respective Sections which have been assigned to them. Without inquiry as to the names of parties or places, they will decide upon the merits of the animals, and their awards shall make reference merely to the *numbers* which distinguish the animals. The Member of the Committee or Deputation of Directors, who attends each section of the Judges, will receive from the Secretary blank reports, to be completed by him, under their instructions, with the awards of the Premiums. In this Report, the *numbers* referable to the lots recommended must be distinctly written in words, and not in figures. The Judges will report not only those animals entitled to Premiums, but also the next in merit in each Section, to meet the contingency of any challenge which may be made against the Prize animals. They will also point out any animals, portraits of which they may consider should be taken for the Society's Museum. They will sign and deliver their Report, and they are not afterwards to propose any change. In the event of a difference of opinion, that of the majority of the Judges who have examined the Lot shall be conclusive. When the Report is delivered to the Committee, the duty of the Judges shall cease, and the Committee shall award the Premiums.

2. The Judges, in examining the Stock, will proceed on the understanding that the Committee are satisfied with the regularity of the Certificates; but if any of the Stock does not, in their opinion, come within the Regulations, or is of such a character as ought not to be exhibited, they will state their opinion to the Committee, that such course may be adopted as shall appear necessary. Should the Judges desire to have the information communicated in the Certificates, as to the mode of feeding or other particulars, they will apply for the same to the Committee through the Secretary.

3. The Judges will have regard to the symmetry, early maturity, purity, size, and general qualities characteristic of the breeds of which they judge. They will make due allowance for age, feeding, and other circumstances, bearing on the character and condition of the animals. They will not give encouragement for over-fed animals. They will not award Premiums for Bulls, Cows, or Heifers, which shall appear to have been fattened for the butcher, the object being to have superior animals of these descriptions for breeding. In no case shall a Premium be adjudged, unless the Judges shall deem the animals to have sufficient merit, more especially if only one lot is presented for any of the Premiums.

THE GENERAL SHOW OF LIVE STOCK,

AND

AGRICULTURAL MEETING AT ABERDEEN IN 1847.

The General Show of Live Stock, and Exhibition of Implements, Roots, Seeds, &c., will in 1847 take place at Aberdeen, when liberal Premiums will be awarded by the Society, aided, as is

confidently expected, by donations from the Noblemen, Gentlemen, and Local Agricultural Associations of the Counties more immediately interested, and from the City of Aberdeen.

The Premiums will be fixed after communication with the Members of the Society in the District, and the Local Associations, and afterwards published for the information of intending Competitors.

THE VETERINARY COLLEGE.

This Establishment is conducted under the superintendence of Professor Dick, Veterinary Surgeon, the Lecturer appointed by the Society. The curriculum of study consists in a course of Lectures on the principles and practice of Medicine and Surgery applied to domesticated animals, by Professor Dick; Anatomy and Demonstrations, by Mr. Barlow, V.S.; Pharmacy, by Mr. Worthington, V.S.; and Chemistry and Materia Medica, by Dr. Wilson, F.R.S.E.

Students enjoy the benefit of witnessing and assisting in an extensive practice. During the year 1845, three thousand five hundred and forty-three cases were treated under their immediate inspection, and ample opportunities afforded them of performing the different operations which most frequently occur.

Attendance at Two Courses is required before a Student is taken upon trial for diploma; and the Graduates of the College are eligible for appointments in the Army and East India Company's Service as Veterinary Surgeons.

The Professors of Agriculture and Anatomy in the University of Edinburgh kindly give gratuitous admission to their classes to PRACTICAL Students of the Veterinary College.

The Lectures and Demonstrations for the Session 1846 and 1847 commence at the Institution in November next, of the particulars of which subsequent advertisements will be given.

THE DISEASE OF POTATOES.

The Highland and Agricultural Society of Scotland, desirous of obtaining information regarding the disease which has so recently affected the Potato crops of this country, earnestly solicits the co-

operation of Societies and individuals in the collecting of such facts, regarding the nature and effects of the disease, as the experience of agriculturists in different parts of the country can supply.

Although certain diseases, as curl, ulceration of the tubers, &c., are known to have attacked the Potato plant, since the period of its extended cultivation in these islands, yet these having been local and partial, have never excited alarm for the safety of the general crop. For several years past, however, there have been partial failures of crops, apparently from the sets undergoing decomposition in the ground after being planted, and before they had put forth stems and leaves. But in the disease now in question, which has excited such general alarm, the plants have appeared to grow vigorously in their first stages, and only to become perceptibly or seriously affected as the tubers advanced towards maturity. What the predisposing causes may be of this dangerous disease we do not as yet know. These causes may, perhaps, escape our knowledge, and may, as in the case of many other diseases of plants, be beyond our control, and all that may be within our power may be to alleviate the effects. The disease has more than once ravaged large tracts of country in North America. Several years ago it appeared in the extreme west of Scotland, as in the island of Mull, and a few other of the Hebrides; but it was only in the past year that it spread over the greater part of Europe. We may indulge the hope, perhaps, that it may not return, or may not occur with the same violence; but we cannot have any assurance that this expectation will be realized, and, therefore, the Society has felt it to be a public duty to endeavour to collect the information on the subject, which the experience of the past season can afford.

The points upon which the Society is especially desirous to obtain information are:

1. At what period in the season, and after what state of the weather, the disease manifested itself, what were the general appearances presented by the stems, leaves, and flowers, and by the tubers, when the taint had extended itself to them.

2. Whether any of the varieties of Potatoes commonly cultivated have escaped the disease, or been less affected than the others; whether potatoes recently obtained from seeds, have been less subject to it than those which have been long raised from sets or tubers; whether any particular condition of the soil, as wetness, previous cul-

tivation, or the kinds of manures used, appear to have had any influence in promoting, retarding, or preventing the disease.

3. What have been the modes employed in storing the Potatoes, and what are the means which have been found most successful in preserving the healthy tubers, and preventing the extension of the taint from the diseased to the sound ones.

It is to those latter points that the Society is especially desirous of calling the attention of the Agriculturists of Scotland. The Society is aware that Farmers have employed various means for securing the crop, as by ventilating the pits, by the use of lime and other substances for absorbing moisture, by a frequent opening of the stores, and separation of the diseased from the sound tubers, &c. It is conceived to be of great importance to ascertain the results of those trials, and the further means which the experience of the growers may suggest, for preserving the crop, in case, unfortunately, the disease should again appear in the present or subsequent seasons.

Parties who can communicate information on any of the points embraced in the above queries, are requested to forward their answers to the Secretary of the Society as soon as possible. Answers may be drawn up in the form most simple and convenient for the author, without regard to the regulations applicable to Prize Essays and Reports.

By order of the Directors.

J[N.] HALL MAXWELL, *Secretary*.

PREMIUMS

OFFERED BY

THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND,

IN

1847.

CONTENTS.

PRELIMINARY NOTICE.

WHEN the HIGHLAND SOCIETY was instituted in the year 1784, and sanctioned by a Royal Charter in 1787, its objects were few, and their operation limited. They were confined almost exclusively to matters connected with the amelioration of the Highlands of Scotland.

But the patronage of certain departments, proper to that part of the country, having been since committed to special Boards of Management, or undertaken by other Associations, the general progress of science, arts, and manufactures, has led to a greater extension and modification of the views of the Society. Several of its earlier objects have thus been abandoned, while others of higher and more general interest have been substituted in their place.

Instead of encouraging improvement in the Highlands only, the patriotic exertions of the Society came to be devoted also to the benefit of the Lowlands, and in both, for the long period of sixty years, the various branches of Agriculture, Rural Economy, or Domestic Industry have been uniformly promoted.

In accordance with this more enlarged sphere of operation, the original name of the Society was altered, under a later Royal Charter in 1834, to the HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND.

The leading purposes contemplated by this Institution, will be sufficiently explicit on perusal of the following pages, and reference to preceding practice.

They embrace, in particular, the advancement of Agriculture in all its departments, and the various branches of Art and Industry connected with it.

There are liberal Premiums awarded for Essays and Reports, on the best and most approved methods of reclaiming waste and barren lands from a state of Nature. Premiums are likewise offered to

encourage improvement in the breeds of Live Stock, pertaining to rural economy, and to direct attention to the proper management of the produce of the Dairy. The beauty and ornament of the country, together with the benefit of shelter, are promoted by Premiums for Woods and Plantations. The comforts and convenience of the humbler classes have been attended to by rewarding habits of order and cleanliness, and by stimulating proprietors to improve the construction of Cottages. Useful inventions and improvements in Agricultural Machinery, and Implements employed in rural economy, are always patronized and remunerated.

Among the more important measures which have been effected, of late years, under the patronage of the Society, are,—

I. The establishment, on an extensive scale, of a Cattle Show and Agricultural Meeting, held annually in different parts of Scotland, at which competitors from all parts of the United Kingdom have an opportunity of exhibiting live stock, roots, seeds, dairy produce, and improved implements employed in husbandry.

II. The establishment of a system of District Shows, instituted for the purpose of improving the Breeds of Stock most suitable for different parts of the country, and of aiding and encouraging the efforts of Local Agricultural Associations.

III. The advancement of the Veterinary Art, and improvement in the mode of treating diseases peculiar to domesticated animals, by the establishment of a Veterinary College in Edinburgh. Courses of Lectures are there delivered by a Professor of distinguished ability in his profession, aided by able assistants; and numerous pupils, some of them resorting from distant quarters, are trained to practice

IV. The erection of an expensive and spacious Museum, adapted to the reception of Models of Implements and Machines, applicable to the various operations connected with Agriculture. Of these a large collection has been formed. The Museum also contains an assortment of vegetable and mineral specimens, and is embellished by the Portraits of Animals, for which Premiums have been awarded at the different exhibitions of Stock.

V. The periodical publication of the Transactions, which comprehend the most interesting and important of the Essays and Reports acquired by the Society through its premiums, or communicated to it

by Local Associations or individuals. The Transactions are published by Messrs. BLACKWOOD and SONS, Edinburgh, simultaneously with the Quarterly Journal of Agriculture.

VI. The establishment of Monthly Meetings, which are held periodically in the Hall of the Museum, when selected papers are read, and subjects in the science and practice of Agriculture are discussed.

VII. The patronage of the Society is generally devoted to whatever promises benefit to the country at large, and more especially to such objects as come properly within its cognizance. Besides, the annual vote of money in support of the Veterinary College, an allowance is granted in aid of the Agricultural Chemistry Association, and the meetings of its Members are occasionally accommodated in the Museum.

Though not now in receipt of any public grant, the Society is in duty bound to acknowledge the pecuniary assistance which it has at different periods received from Government, and the countenance and support which have ever been extended to it, by means of which, its efforts for disseminating the spirit of improvement throughout Scotland have been invigorated.

CONSTITUTION AND ESTABLISHMENT.

The whole affairs of the HIGHLAND AND AGRICULTURAL SOCIETY are conducted under the sanction and control of a Royal Charter, which authorizes the enactment of Bye-Laws.

The Office-Bearers consist of a President, four Vice-Presidents, thirty Ordinary and ten Extraordinary Directors, a Treasurer, and an Honorary and Acting Secretary.

The Ordinary Directors are subdivided into Committees for the dispatch of business, assisted by those Members of the Society most conversant with the subjects to be considered, or with the duties to be discharged. The Minutes of each Committee are brought before the Board of Direction for approval, and the general proceedings are reported to half-yearly General Meetings of the Society, one of which is, by the Charter, appointed to be held on the second Tuesday of January, and the other on such day in the months of June or July as the Directors may fix.

New Members are admitted at either of these General Meetings by Ballot. No entry-money is paid on election, but each Member contributes £1, 3s. 6d. annually, which he may redeem for £12, 12s. or for less, according to the number of annual payments he may have made. Subscriptions are payable in advance, and must be remitted to the Secretary without expense to the Society.

Meetings of Directors, or of Committees, are open, and at these any Member may attend and deliver his opinion on the subject under consideration, but Directors or Members of Committees, only, are entitled to vote.

All communications are to be addressed to John Hall Maxwell, Esq., the Secretary of the Society, 6, Albyn Place, Edinburgh.

GENERAL REGULATIONS FOR COMPETITORS.

When subjects are specially selected for competition, it is always to be understood, 1st, That however concisely the subjects themselves be announced, ample information is required concerning them —2d, That this information shall be founded on experience or observation, and not on simple references and quotations from books— 3d, That it shall be digested as methodically as possible—and 4th, That Drawings, Specimens, or Models, adapted to a defined scale, (3 inches to the foot, if convenient) shall accompany writings requiring them for illustration.

Certain conditions are annexed to each of the various subjects of competition, as detailed in the List of Premiums; and these are rigidly enforced by the Society, as the only means of insuring regularity in the conduct of the business, and of distributing exact justice among the Competitors.

In all Essays for Competition for Premiums offered, it is expected that when facts not generally known are stated, they will be authenticated by proper references. Competitors in Essays and Reports are required to quote, or state distinctly on the top of the first page of their paper, the *number* and *title* of the subject or Premium for which they compete. They must not communicate their names,

but transmit, along with the Essays, a sealed note, containing their names and addresses, and inscribed on the back with some distinguishing motto or device, which shall also be inscribed on the Essay. When this regulation is neglected, such Essay shall not be received in competition. If the Essayist has formerly gained a Premium from the Society for a Paper communicated by him, it is recommended, that his subsequent Essay should be written in a different hand from that of the former successful Paper. All communications designed for Competition must be written in a distinct and legible hand.

None of the sealed notes, except those that bear the distinguishing motto or device of the Essays found entitled to Premiums will be opened; and the sealed note will not, in any instance, be opened, without the consent of the author, unless a sum equal to, at least, one-half of the Premium offered shall have been adjudged. But should no application be made for the paper on or before the 1st of March in each year, it will be held as belonging to the Society. Such Essays as are not found entitled to any Premium will, with the sealed notes, be returned to the authors if required.

Essays for which a Premium, or one-half of it, has been awarded, become the property of the Society, and cannot be published in whole or in part, nor circulated in any manner without the consent of the Directors.

When communications from Local Associations are inserted in the Transactions, opportunities will be given for obtaining separate copies from the types, for circulation in their Districts.

Models accompanying communications on Agricultural Machinery, for which Premiums have been awarded, become the property of the Society, a reasonable sum being allowed to the Inventor for the expense of construction.

Candidates are requested to observe, that, in any instance, when Essays, Reports, or Certificates, are unsatisfactory, the Society is not bound to give the reward offered; and that, in certain cases, power is reserved of giving such part only of a Premium as the claim may be adjudged to deserve; but Competitors may feel assured, that the Directors will always be inclined to judge liberally of their several claims.

Essays, Reports, or Communications, on subjects for which Premiums have in former years been offered, will still be received,

although the subjects may now be discontinued on the List, and Honorary awards will be voted, when the communications appear to merit them.

Essays and Reports, for which no Premiums have been awarded, must, if desired to be returned, be called for within one year from the date of Competition, otherwise the Society will not be responsible for the papers.

Competitors will understand it as a condition having reference to every Premium and Reward offered by the Society, that the decisions of its Committees and Board of Directors, as confirmed by the Society, are to be final and conclusive, and that it shall not be competent to raise any question or appeal touching such decisions before any other tribunal.

In Reports of Experiments relating to the Improvement or Management of Land, it is expected that the expenses shall be accurately detailed.

In all Premiums offered, having reference to Weight or Measure, the New or Imperial Standards are alone to be understood as referred to; and Competitors are required to state their calculations according to these, the only legal standards, otherwise the claim will not be entertained.

Medals will be awarded for communications of interest, which the Directors may think fit to bring before the Monthly Meetings. Parties making such communications are not required to observe the conditions applicable to Essays and Reports in competition, but are invited to transmit them to the Secretary in the form and manner most convenient for themselves.

When the Premiums are awarded in Medals or Plate, the Society will, in such cases as the Directors may see proper, allow them to be paid in money, on the application of the successful Candidates.

The Premiums awarded by the Society, are payable after the 10th February, for the preceding year. Orders, payable at the Royal Bank of Scotland, are issued by the Directors, in name of the parties in whose favour the Premiums have been awarded. The orders will be delivered at the Society's Hall, upon the receipts of the parties to whom the Premiums have been adjudged being presented; or the parties may transmit, through any Bank, stamped receipts, or negotiate bills, addressed to the Secretary, if done

without expense to the Society. The receipt or bill must specify distinctly the Premium in discharge of which it is sent.

Parties entitled to *Plate* or *Medals*, will, by themselves, or some person having their authority, apply at the Society's Hall, for an order on the Society's Jeweller or Medallist.

Premiums not applied for within two years from the term of payment, will be forfeited.

ESTABLISHMENT FOR 1847.

PRESIDENT.

His Grace JAMES, DUKE of MONTROSE.

VICE-PRESIDENTS.

1846. The Right Honourable FRANCIS WILLIAM, EARL of SEAFIELD.
1846. The Right Honourable THOMAS ALEXANDER, LORD LOVAT.
1847. The Right Honourable GEORGE HAMILTON, EARL of ABERDEEN.
1847. The Right Honourable JOHN, VISCOUNT ARBUTHNOTT.

EXTRAORDINARY DIRECTORS.

1846. Sir GEORGE SINCLAIR of Ulbster, Bart.
1846. Lieut.-General Sir HUGH FRASER of Braelangwell, K.C.B.
1846. Colonel HUGH DUNCAN BAILLIE of Redcastle, M.P.
1846. CHARLES LENNOX CUMMING BRUCE of Roseisle and Kinnaird, M.P.
1846. GEORGE DEMPSTER of Skibo.
1847. Major-General the Right Hon. LORD JAMES HAY.
1847. Sir JOHN MACPHERSON GRANT of Ballindalloch, Bart.
1847. Colonel THOMAS GORDON of Park.
1847. Captain ROBERT BARCLAY ALLARDICE of Ury.
1847. WILLIAM INNES of Raemoir.

Alexander Maconochie, of Meadowbank, *Treasurer.*
John James Hope Johnstone, of Annandale, M.P. *Honorary Secretary.*
John Hall Maxwell, yr. of Dargavel, *Secretary.*
Archibald Horne, *Accountant.*
Rev. James Grant, D.D., St. Mary's Church, Edinburgh, *Chaplain.*
Henry Stephens, *Editor of Transactions.*
Messrs. Blackwood, *Publishers.*
Charles Lawson, *Seedsman and Nurseryman.*
William Dick, *Professor at the Veterinary College.*
James Mackay, *Goldsmith and Jeweller.*
Alexander Kirkwood, *Practical Medallist.*

ORDINARY DIRECTORS.

1844. Robert Balfour Wardlaw Ramsay of Whitehill.
1844. Sir John Hope of Pinkie, Bart., M.P.
1844. Sir John Graham Dalyell of Binns, Bart.
1844. Captain C. K. Johnstone, Alva, K.L.S.
1845. Thomas Mackenzie of Applecross, M.P.
1845. Thomas Maitland of Dundrennan, M.P., Solicitor-General for Scotland.
1845. William Mackenzie of Muirton.
1845. Captain Thomas Christie, R.N.

1845. Sir JOHN STEWART RICHARDSON of Pitfour, Bart
1845. GEORGE TURNBULL of Abbey St. Bathans.
1846. DONALD HORNE of Langwell.
1846. WILLIAM MURRAY of Henderland.
1846. Right Hon. JAMES, LORD BERRIEDALE.
1846. JOHN GORDON of Cairnbulg.
1846. Sir WILLIAM DUNBAR of Mochrum, Bart.
1846. ROBERT GRAHAM of Balgowan.
1846. JOHN HUTTON BALFOUR, M.D., Professor of Botany in the University of Edinburgh.
1846. ROBERT G. BAILLIE of Coulterallers.
1846. DAVID LOW of Laws, Professor of Agriculture in the University of Edinburgh.
1847. ROBERT GRANT of Kincorth.
1847. Sir WILLIAM JARDINE of Applegarth, Bart.
1847. WILLIAM GREGORY, Professor of Chemistry in the University of Edinburgh.
1847. JAMES WEMYSS of Wemyss-Hall.
1847. JOHN FINNIE, Swanston.
1847. JOHN TROTTER of Bush.
1847. ALEXANDER SCOTT, Craiglockhart.
1847. ALEXANDER PRINGLE of Whytbank.
1847. WILLIAM SMITH of Carbeth Guthrie.
1847. JAMES HORN BURNETT, W.S.
1847. ALEXANDER FORBES IRVINE, yr. of Drum.

CHAIRMEN OF STANDING COMMITTEES, 1847.

Funds and Accounts, ...	GEORGE TURNBULL of Abbey St. Bathans.
Publications and Papers, ...	Professor GREGORY.
Mechanics, ...	Sir JOHN GRAHAM DALYELL of Binns, Bart.
Geology and Chemistry, ...	DAVID MILNE of Milnegraden.
Cottages, ...	R. G. BAILLIE of Coulterallers.
Veterinary College, ...	JOHN BURN MURDOCH of Gartincaber.
General Shows, ...	DONALD HORNE of Langwell.
Argyll Naval Fund, ...	ALEXANDER LAMONT of Knockdow.

MUSEUM.

The Right Honourable LORD BERRIEDALE, *Chairman.*
ROBERT GRAHAM of Balgowan, *Deputy-Chairman.*
CHARLES LAWSON, *Conservator.* THOMAS DICKSON, *Assistant-Conservator.*
JAMES SLIGHT, *Curator of Models.*

CHAIRMEN OF MONTHLY MEETINGS

HELD AT THE MUSEUM.

Chairman.—The Right Honourable the EARL of ROSEBERY.
Deputy-Chairmen.—LORD MURRAY ; ALEXANDER MACONOCHIE of Meadowbank ; RICHARD TROTTER of Mortonhall ; JAMES MAITLAND HOG of Newliston.

PREMIUMS.

THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND offers the following PREMIUMS for Competition in 1847, and subsequent years :—

CLASS A.

ESSAYS AND REPORTS.

§ I. ON SUBJECTS CONNECTED WITH THE SCIENCE AND PRACTICE OF AGRICULTURE.

1. DRAINING.

For an approved Report on Draining, specifying the most approved methods of modern practice, as applicable to various soils and localities in Scotland—The Gold Medal, or Ten Sovereigns.

The Report must state the dimensions of the Drains—their distance from each other—the expense of their construction, and the comparative advantages of Pipe Tiles of different sizes, and the other Drain Tiles of the various known forms.

Reports to be lodged by 10th November 1847.

2. EXPERIMENTS IN DEEP PLOUGHING.

For an approved Report of experiments made to ascertain the results of subsoil ploughing, trench ploughing, or any other mode of deep ploughing on thorough drained land, or on land that does not require draining, with the comparative advantages of the different modes on the same soil—The Gold Medal, or Ten Sovereigns.

The Experiments must be made on not less than four acres of land of, as nearly as possible, the same soil and description, one-half of which shall have been deep ploughed, and the other half cultivated in the ordinary way. The whole extent of ground to be under the same description of crop, and to be cultivated and managed alike. The Report must state the nature of the Soil and Sub-soil—the quantity and quality of the produce of each portion—the depth reached by the Plough, and such observations as may be deserving of attention.

Reports to be lodged by 10th November in any year.

3. SPADE AND FORK HUSBANDRY.

For an approved Report on Delving and Subsoiling by the joint operation of the Spade and Fork—The Gold or Medium Gold Medal.

The Report must contain a description of the Implements, with measurements of their principal parts, and the cost of the whole. It must state the mode of using them—the circumstances in which they are particularly applicable—the peculiar advantages which they may possess, and the most eligible plan for insuring the uniform sufficiency of the work—the expense of Tillage by them, per acre, on different soils—the depth to which the ground can be conveniently penetrated by them, and the average quantity of work which two men can execute with them in a-day.

Reports to be lodged by 10th November 1847.

4. ANALYSES OF THE ASHES OF PLANTS.

For an approved Series of Quantitative Analyses of the Ashes of the Cultivated Plants, or of the more common weeds growing on the different soils in Scotland—Fifty Sovereigns.

As the Society has already offered Premiums for the Analyses of Oats and Potatoes, Competitors who make choice of cultivated plants will select any of the others in common cultivation, as wheat, barley, turnips, or beans.

The more abundant weeds should also be selected for analysis, full grown healthy plants being in every case taken. Of such weeds, the following may be enumerated:—*Sinapis arvensis*, common wild mustard or charlock. *Raphanus Raphanistrum*, or jointed charlock. *Triticum repens*, couch grass, or quick grass. *Arrhenatherum avenaceum*, oat grass. *Senecio Jacobæa*, ragwort. *Bellis perennis*, common daisy. *Ranunculus acris*, *repens* and *bulbosus*, common buttercups. *Sonchus oleraceus* and *arvensis*, sow thistles. *Taraxa-*

cum officinale, dandelion. *Rumex obtusifolius* and *crispus*, common docks. *Carduus arvensis* and *lanceolatus*, common thistles. *Spergula arvensis*, corn spurrey; and *Tussilago Farfara*, common colt's foot.

Separate analyses should be made of the stalk of the plant and of the seeds, and in the turnip or other plants with large roots, also of the bulb. Intending Competitors are referred to the latest edition of Liebig's Agricultural Chemistry; and for an account of the best method of ash analysis, to a paper by Drs. Will and Fresenius, on the inorganic constituents of plants, in the Memoirs of the Chemical Society of London, Part 9.

Reports to be lodged by 10th November 1848.

5. CONSTRUCTION OF TANKS.

For an approved Report on the most economical method of constructing Tanks for collecting liquid manure from stables, byres, and pigstyes, suitable to ordinary farm-steadings; and also on the best means of draining off from the dung-hill the liquid manure into the Tank—Ten Sovereigns.

Competitors to state the most eligible materials for the purpose, the expense, and the form and proper dimensions in proportion to the number of cattle, &c., the best mode of drawing off the contents and of applying it to the soil.

Reports to be lodged by 10th November 1847.

6. SPECIAL MANURES.

Fifty Sovereigns will be awarded in such proportions as the Directors may see proper.

1. For an approved Report of experiments made with different manures, both *separately* and *mixed in certain proportions*, and applied either in solid or fluid form. Each experiment to be made *double*,—that is, on two separate portions of land of not less than one-eighth of an acre.

The substances employed may be Guano, Nitrate of Soda, Nitrate of Potash, Sulphate of Soda, Sulphate of Magnesia, Sal Ammoniac, Sulphate of Ammonia, Carbonate of Soda, Pearl Ash, Kelp, and Bones, or mixtures of these in specified proportions, and any others of known composition, which the Experimenters may select. Poudrette or Prepared Night Soil, Liebig's Patent Manures, and the Ammoniacal liquor of Gas Works should also be tried; and it is particularly recommended that the refuse of Manufactories, such as the Prussiate of Potash, the animal refuse of Sugar Works, and the refuse

of Salt Works, Bleach Works, and Glue Manufactories, should be collected and experimented upon.

It is desirable that separate Experiments should be made with different quantities of each substance; and different proportions of two or more substances may be contrasted with each other. It is recommended that Experiments, with mixtures, should form a prominent part in the trials. The proportions of the several substances which are mixed, must in all cases be stated.

The quantity by weight, and the cost of the manures employed (including carriage, and every other expense), as well as the quantity and quality of the crop produced by each, must be accurately ascertained and reported, with the nature and qualities of the soil, its altitude, exposure, drainage, and such other particulars and observations as the Reporter may deem deserving of attention.

The general conclusions and remarks which the Reporters may deduce from the results of their experiments, are to be drawn up separately from the Tables, and to be inserted immediately after their respective series of experiments; and in every instance it is hoped that these shall be as complete as the circumstances and opportunities for observation will admit.

While the number of the experiments will be taken into account, the preference will be given to those which have been performed with the greatest accuracy. The value of the experiments will be enhanced, if accompanied with an analysis or minute description of the soil on which they are made, and means of proving the purity of the manures which were used.

The Society earnestly requests the attention of Landed Proprietors to this important subject, and solicits from all quarters Reports of carefully conducted Experiments, however small they may be. Those who have no intention to compete for the Premiums, may yet obtain results which the Society would gladly record in their Transactions.

Reports to be lodged by 10th November 1847.

2. For an approved Report, having reference to the experience of two or more preceding seasons, on the effects which any of the substances above named exert on the soil for a certain period after their application. In all cases, the subsequent produce of the land, which had received the special manure, must be noted carefully by weight or measure, and compared with that of an equal portion of land which had received no special manure.

Blank Tables for reporting the results of the Experiments, in either of

the divisions of this subject, will be supplied on application at the Society's Hall, under signature of the motto intended to be adopted by the Competitor.

Reports to be lodged by 10th November 1847.

7. COMPOST HEAPS.

For an approved Report on the management of Compost Heaps, which, when applied in the ordinary course of management, have proved a profitable auxiliary to, or substitute for, the regular manure produced on the farm—The Gold Medal, or Ten Sovereigns.

The Report must state the substances employed; the crops to which they have been applied; the nature of the land, and its previous management, and the results of the application. The attention of Competitors is directed not only to the use of such substances as may be found on the farm itself, as vegetable refuse, peat and coal ashes, the mud of ponds and ditches, the scrapings of roads, &c., but to such foreign substances as they may have been able to mix with the matter of the heaps, and which have been found to add to their quantity and usefulness, such as the offal of shambles and fishing-stations, the refuse-matter of manufactories, and any other substances which can be rendered available as manures.

Reports to be lodged by 10th November 1847.

8. RELATIVE VALUE OF MANURES PRODUCED BY DIFFERENT KINDS OF FEEDING.

For an approved Report of the result of experiments for ascertaining the relative value of Farm-yard Manure, obtained from cattle fed upon different varieties of food, by the application of such manures to farm-crops—The Gold Medal, or Ten Sovereigns.

The Report must state the effects produced on two successive Crops, by the application of manures obtained from cattle fed upon turnips and straw alone, and from cattle fed upon turnips and straw, with an addition of oil cake or flax seed; also from cattle fed upon these substances, with the addition of bean meal, or grain. It is desirable that the animals from which the manures are to be obtained, should be as nearly as possible of the same age, weight, condition, and maturity, and that to each lot, the same quantity of litter, per head, should be given daily, and that the animals, except as to the difference of food given to them, should be treated in every respect alike.

The preparation of the Manure by fermentation or otherwise, should be

in every respect the same, and it is desirable that not less than two several Experiments be made with each kind, and that the ground to which it is to be applied, be as equal as possible in quality, and treated in every respect alike.

Reports to be lodged by 10th November 1849.

9. CULTIVATION OF RED CLOVER.

For an approved Report on the best mode of managing Lands which have become sick or tired (as it is termed) of common Red Clover, *Trifolium pratense*, so as to restore their capability of properly yielding that crop for hay, &c., without altering the generally practised system of rotation—The Gold Medal, or Ten Sovereigns.

Reports to be lodged by 10th November 1847.

10. IMPROVEMENT AND MANAGEMENT OF NATURAL MEADOW.

For an approved Report on the improvement of Natural Meadow by draining, top dressing, or other means, and on the subsequent management by manuring, or irrigation, and where pasturing is to be adopted, on the system whereby it may be rendered as little injurious as possible—The Gold Medal, or Ten Sovereigns.

Reports to be lodged by 10th November 1847.

11. CLOVERS AND GRASSES FOR TWO OR THREE YEARS' PASTURE.

For an approved Report on the suitable proportions and kinds of Clovers and Grasses for two and three years' pasture—The Gold Medal, or Ten Sovereigns.

The Society being anxious to induce Farmers to ascertain, from actual experiment and observation, the most suitable proportions and kinds of the Clovers and Grasses to sow, with the view of obtaining the greatest amount of pasture, where the land is only to rest for two or three years at most, has offered the above premium, in the hope that practical Farmers will turn their attention to this matter, and that by a judicious selection of seeds, as well as by adopting a satisfactory method of arriving at the results, new light may be thrown on this branch of Farm management.

Reports to be lodged by 10th November 1850.

12. COMPARATIVE PRODUCTIVENESS, ETC., OF DIFFERENT VARIETIES OF THE CEREAL GRAINS.

1. For an approved Report, founded on actual experiment and

observation, on the comparative earliness, productiveness, and profit in Grain and Straw, of the different varieties of Oats generally sown, where wheat is a crop in the rotation—The Medium Gold Medal, or Five Sovereigns.

Reports to be lodged by 10th November 1848.

2. For an approved Report, founded on actual experiment and observation, on the comparative earliness, productiveness, and profit of the different varieties of Oats generally sown, where wheat is not a crop in the rotation—The Medium Gold Medal, or Five Sovereigns.

Reports to be lodged by 10th November 1848.

3. For an approved Report, founded on actual experiment and observation, on the comparative earliness, productiveness, and profit of the different varieties of Barley.

Reports to be lodged by 10th November 1848.

4. For an approved Report, founded on actual experiment and observation, on the comparative earliness, productiveness, and profit of the different varieties of White and Red Wheat generally sown. —The Medium Gold Medal, or Five Sovereigns.

Reports to be lodged by 10th November 1849.

As the Society, by offering these Premiums, has the practical object in view of inducing Agriculturists to acquire a more perfect knowledge of the varieties of grains most profitable for cultivation on various soils, and in different Districts, the attention of practical farmers, it is hoped, will be generally turned to the investigation.

Competitors must sow at least one bushel of each variety, and are requested to direct their attention to the selection of new and improved varieties, so as to test their productiveness, earliness of ripening, &c., with those generally in use. The seed of each sort must be as equal in quality as possible, and the Experiment must be conducted with care and accuracy, and on a field of uniform soil and condition.

Reports must state the altitude, exposure, drainage, and nature of the soil—the dates of sowing, brairding, ripening, reaping, and thrashing—the produce per acre in grain and straw—the quantity of marketable and light grain—and the weight of each per bushel. The Premium-book of 1848 will contain a tabular form for reporting these particulars.

13. IMPROVED VARIETIES OF AGRICULTURAL PLANTS.

For an approved Report, founded on actual experiment, detailing

the means which may have been successfully employed by the Reporter for obtaining new and superior varieties, or improved subvarieties, of the different cultivated Grains and Grasses, Clovers, Beans, Peas, Turnips, Potatoes, or other Agricultural Plants, either by minute attention to the selection of the Seed, by hybridation, or such other means as may have been found efficacious—The Gold Medal, or Ten Sovereigns.

It is necessary that the varieties and subvarieties reported upon shall have been proved capable of reproduction from seed, and also that the relation they bear to others, or well known sorts, shall be stated. The Reporter is farther requested to mention the effects that he may have observed produced by different soils, manures, &c., on the plants forming the subjects of report, and how far he may have ascertained such effects to be lasting.

NOTE.—Should any improved variety reported upon be the result of direct experiment by cross impregnation, involving considerable expense and long-continued attention, a higher Premium will be awarded.

Reports to be lodged by 10th November 1847.

14. FLAX.

For an approved Report on the cultivation of Flax—Twenty Sovereigns.

The Experiment must be made on a portion of land of not less than 10 acres—one half of which shall be under Flax, and the other under the ordinary Rotation. The same amount and kind of manure to be applied to each portion. The Report must state the management of the Flax Crop, the expense and the profit, as compared with that of the ordinary crop. The comparative value of the succeeding crops on each portion is also to be stated. They are to be of the same description, and in all respects treated alike. The altitude of the locality, and the nature and composition of the soil, with its previous management, must be given.

Reports to be lodged by 10th November 1849.

15. POTATO BLOSSOMS.

For an approved Report on the results obtained, as to the quality and quantity of the crop, by picking the blossoms from the stems of the potatoes, instead of allowing the germs to ripen into seed apples—The Medium Gold Medal, or Five Sovereigns.

The trials to be made with different varieties of Potatoes, and on portions of not less than one-eighth of an acre each, care being taken in removing the flowers that the stems are not injured.

Reports to be lodged by 10th November 1847.

16. SUBSTITUTES FOR THE POTATO.

1. For an approved Report on the best *Field Crops* to be adopted in Scotland, as auxiliary to Potato Culture, founded as far as practicable on experiment or observation—The Gold Medal, or Ten Sovereigns.

2. For an approved Report on Crops of Esculent Vegetables, best adapted for *garden culture*, as auxiliary to the Potato crop—The Gold Medal, or Ten Sovereigns.

Attention is called to mangel wurzel, beet, carrot, Jerusalem artichoke, parsnip, cabbage, kohlrabi, salsafy and scorzonera.

17. VEGETABLE PRODUCTIONS OF INDIA, CHINA, AMERICA, ETC.

For an approved Report, on the Hardy, or supposed Hardy Trees, and useful Herbaceous Plants, including Grains and Grasses, of China, the Himalaya country, the Falkland and South Sea Islands, California, and the high north-western districts of America, or any other country, where such climate exists as to induce the belief that the Plants may be beneficially introduced into the cultivation of Scotland—The Gold or the Medium Gold Medal, according to the merits of the communications.

There being reason to believe, that, in addition to the useful vegetable productions which have of late years been introduced from Upper India, California, &c., many others may exist in the same regions, and in China, equally well suited to this climate, the Society has been induced to offer the above Premiums, for the purpose of obtaining the fullest information, relative both to the unintroduced sorts, and those already known in this country, with the view of encouraging the introduction of the former, and the more extended culture of the latter. Reporters are, therefore, required to give the generic and specific names, with the authority for the same—together with the native names, in so far as known; also, to state the elevation of the locality and nature of the soil in which they are cultivated, or which they naturally inhabit, with their qualities or uses; and it is further requested, that the descriptions be accompanied, in so far as possible, with specimens of the plants and their fruit, seed, timber, or other products.

The transmission of living plants, in cases covered with glass, may be attempted where practicable, the cases being exposed to light, and

the external air being excluded, and almost no water given during the voyage. Where this plan is adopted, smaller seeds, berries, or heps, may be thickly mixed with the soil or earth in which the plants are placed. Seeds may be sent home in the cones, wrapped in brown paper, packed in a box, to be kept in a cool, airy part of the cabin, but on no account in the hold, nor in close tin cases. In the event of the seeds of Coniferæ being separated from the cones, with the view of lessening the bulk and weight of packages, intended for overland carriage, hasty and severe heating, in extracting the seeds, should be carefully avoided.

Reports to be lodged by 10th November in any year.

18. TUSSAC GRASS.

For an approved Report, founded upon actual experience, on the cultivation in this country, of the Tussac Grass, *Dactylis cæspitosa* —The Medium Gold Medal.

Seeds of this Grass having been introduced into Scotland from the Falkland Islands, where it grows in great luxuriance, chiefly on Peaty Soils, within the influence of the sea, this premium is offered, in order that the result of experiments may be publicly known, to determine if the extended cultivation of the Plant in this country would be beneficial.

Parties who have received portions of Seed transmitted to the Society by the Colonial Secretary, are expected to report on the results of their Experiments, including all the particulars regarding them, whether successful or not.

Reports to be lodged by the 10th of November 1847.

19. FEEDING OF STOCK.

1. EFFECTS OF DIFFERENT KINDS OF FOOD ON WEIGHT OR MILK.

For an approved Report of experiments for ascertaining the actual addition of weight to *growing* and to *fattening* stock of all kinds, respectively, by the use of different kinds of food, as well as the exact effect of weighed quantities of food of different kinds, upon the quantity and quality of milk, in full grown milk cows in calf and not in calf—Twenty Sovereigns.

The attention of the Experimenter will be drawn to the effects of Turnips, Carrot, Beet, Potatoes, or other roots, as well as to those of Beans, Oats, Barley, Indian Corn, Flax Seed, and Oil Cake, and to the opinion that warmth is equal to a certain amount of food.

Before commencing the comparative experiments, the animals must be

fed on equal quantities of the same kinds of food for some weeks previously.

The animals tried against each other should be, as nearly as possible, of the same age, weight, condition, maturity, and purity of breed. Different breeds may be compared, and this will form an interesting experiment of itself.

The animals are to be treated, in every respect, alike. The food and drink to be regularly weighed and measured, and samples of the food (when this can be done,) carefully analyzed. The live and, if killed, the dead weights of the animals, at the close of the experiment, should be ascertained, and the quantity of tallow which they yield.

Reports to be lodged by 10th November 1847.

2. NUTRITIVE PROPERTIES OF TURNIPS RAISED WITH DIFFERENT MANURES.

For an approved Report on the progressive improvement and increase in weight, (during a period of at least four months) of three lots of cattle, of not fewer than four in each lot, fed on turnips and straw, or turnips and hay, in the following manner—Twenty Sovereigns.

1. Four fed on turnips grown with guano alone.
2. Four fed on turnips grown with farm-yard manure alone.
3. Four fed on turnips grown with one-half of the guano and one-half of the farm-yard manure.

The Premium is offered with the view of ascertaining the comparative feeding properties of Turnips grown with guano, and with farm-yard manure.

The animals selected to be as nearly as possible of the same age, weight, condition, and breed, and to be treated in a similar manner in every respect.

The live weights of the animals to be ascertained before they are put up to feed, as well as at the close of the experiment, and if the animals are slaughtered, the dead weight and quantity of tallow which they yield respectively.

The turnips grown with the different manures to be on land of equal quality and in equal condition, and the quantity supplied to each lot to be weighed.

Reports to be lodged by 10th November 1847.

20. PLEURO-PNEUMONIA—OR CATTLE EPIDEMIC.

For a Report founded on experience and observation, personally

made, on the prevailing Epizootc in Cattle, called Pleuro-Pneumonia —its causes, immediate and remote—the symptoms, from its earliest attack, throughout the disease—the best and most scientific mode of treatment in its various stages, and the most likely means of preventing its occurrence—The Gold Medal, or Ten Sovereigns.

Reports to be lodged by 10th November 1847.

21. THE STRUCTURE AND PROPERTIES OF WOOL.

For an approved Report on the Structure, Conformation, and Physical Properties of Wool; and on the Nature and Uses of the Sebaceous Secretion of the Skin of the Sheep—the Yolk—The Gold Medal, or Ten Sovereigns.

Under the former head must be included a detailed description of the different kinds of Wool which are at present cultivated in the United Kingdom, with deductions as to their comparative value and utility for manufacturing purposes; and under the latter, the special influences which the yolk exerts upon the Wool, the necessity or inutility of artificial salving, and in those circumstances where such has been used, the safest and most efficacious methods of removing it from the fleece, and the bleaching and purifying of the Wool from the "gilting" that may have resulted from its application.

Reports to be lodged by 10th of November 1847.

22. RURAL ECONOMY ABROAD.

For approved Accounts, founded on personal observation, of any useful practice in Rural or Domestic Economy, adopted in other countries, which may seem fitted for being introduced with advantage into Great Britain—The Gold or Silver Medal, according to the merits of the communication.

The purpose chiefly contemplated by the offer of this Premium is to induce gentlemen who may visit other countries, to take notice of, and record such particular practices as may seem calculated to benefit their own country in the branches of the arts referred to. The earliest opportunity will be taken of communicating the Reports to the public.

Reports to be lodged by 10th November in any year.

§ II. WOODS AND PLANTATIONS.

1. EXTENSIVE PLANTING.

To the Proprietor who shall, within a period of five years immediately preceding, have planted on his property the greatest extent of ground, not being less than 150 acres, and who shall communicate to the Society a satisfactory report of his operations, embracing the expense, description of soil, age, and kind of trees planted, the number of each sort per acre, mode of planting, extent of "beating up," and general progress of the plantation, with such observations as his experience may suggest—The Gold Medal.

Although not a Condition, it will be a recommendation, that the Report contain a notice of the underlying rocks, and of the geological features of the district.

Reports to be lodged by 10th November in any year.

2. RECENT PLANTATIONS.

For an approved Report, by a proprietor, of plantations formed by him on his own property to an extent of not less than fifty acres, within a period of not more than ten nor less than four years preceding the date of his Report—The Gold Medal.

The Report should comprehend every interesting particular: among others, the exposure and altitude of the place, and general character of the soil—whether lime has been used, and, if so, its mode of application and apparent effect—the same of any sort of manure or other fertilizing substance—the mode of fencing and of planting adopted—the kind of trees planted, and the number of each kind per acre—their relative progress—the proportion of blanks and deaths at the end of three years—the system of management—the state of the plantations at the date of making the Report, and the expense per acre, as nearly as can be calculated.

Reports to be lodged by 10th November in any year.

3. PLANTING WITHIN THE INFLUENCE OF THE SEA, OR ON BARREN TRACTS.

For an approved Report on successful Planting within the influence of the sea, or on very bleak, peaty, or sandy tracts, founded on

observation of the habits and appearance of the different sorts of trees considered as best suited for such situations—The Gold Medal, or Ten Sovereigns.

Great disappointment having arisen to landed proprietors, in different parts of this country, in planting Waste Grounds, especially on the sea coast, the above Premium is offered, with a view of directing attention to the subject.

Information is particularly desired regarding trees calculated for growing in situations unfavourable to most of the more generally cultivated sorts, as in bleak heaths, barren sandy links, and exposed maritime situations; and with respect to the last of these, the value of the *Pinus Pinaster*, or the more hardy variety of that tree from the downs of Bourdeaux, (called *Pinus maritima minor*) should be ascertained.

The reporter is requested to specify the nature of the surface soil; and although not a condition, it would be a recommendation that the Report contain a notice of the underlying rocks, and of the geological features of the District, with its elevation, exposure, and distance from the sea.

Reports to be lodged by 10th November in any year.

4. FORMATION OF ARBORETUMS.

For an approved Report by a proprietor in Scotland on the formation of the most varied, extensive, and judiciously arranged collection of hardy, or supposed hardy, forest and ornamental trees—either *species*, or marked *varieties*—Twenty Sovereigns, or a piece of Plate of that value.

There is reason to believe that important arboricultural knowledge may be obtained by the judicious formation of Arboretums in various parts of the country, where opportunities may be afforded of comparing the growth and habits of the different species and varieties of Hardy Trees. It is required, therefore, that such Arboretum shall be formed, so as to afford proper space for the future development of each specimen. The Report must specify the date of planting, with the age and height of each specimen at that time. It must also state, whether the tree is a seedling, a cutting, a layer, or a grafted plant; and if the latter, on what stock it had been grafted. Information must be afforded, relative to the nature and previous preparation of the soil, the altitude and exposure of the place; mentioning, also, whether it be in the vicinity of a large town, manufactory, lake, or marsh, where smoke or hoar frost may be supposed to exert their influence on the growth of the plants generally, or on

any particular section or sections of them. Any means used for protecting or fencing the Arboretum should be stated.

It is desirable that the Report should be accompanied with a correct plan of the Arboretum, showing the relative disposition of each specimen. In cases where such a plan cannot well be made, (as, for example, when an Arboretum is formed on the sides of an approach to a mansion-house, which will often be found an admirable locality for the purpose,) an accurate description of the distribution and arrangement of the trees must be given.

Reports to be lodged by 10th November in any year.

5. DISEASES OF THE LARCH.

For an approved Report on the Diseases which prevail in the Larch Plantations of Scotland—Twenty Sovereigns, or Plate of the same value.

The writer is required to describe the different diseases commonly called *heart rot, canker*, and *white bug*, and to state the manner in which they appear to affect various parts of the plant, as the root, the trunk and bark, the leaves, and the fruit or cones. He is required to direct attention to the annual layers in the wood of trees that have been felled, so as to ascertain, if possible, the period or year in which a decay of vigour first exhibited itself in the plants affected.

The writer is farther requested to state the age at which the diseases most generally manifest themselves; the situations in which they have chiefly appeared, with respect to the geological formation; the wetness, dryness, stiff nature, or other conditions of the soil or subsoil; elevation, exposure, checks of growth from pruning or other causes, and evils arising from inattention to proper thinning; and to mention whether the larch had been planted soon after a previous crop of Scotch fir or other timber had been removed from the ground. He is especially required to observe, whether, and under what circumstances, trees have, in any case, escaped injury, or whether from any obvious cause the diseases, after appearing, have spontaneously ceased; and he is requested to ascertain, as far as possible, the kinds of seed that have been used, whether they have been derived from the cones of trees cultivated in this country, or procured from the forests of Switzerland and the Tyrol.

Farther, as it is highly important to ascertain if any means exist of averting the progress of decay, and restoring the vigour of the trees affected, experiments with this view will be considered with especial favour.

The Report should be accompanied with such specimens of the timber, soils, rocks, &c., as may tend to illustrate any particular remarks or opinions of the author.

Reports to be lodged by 10th November 1847.

6. PLANTING ON PEAT MOSS.

For an approved Report on Plantations formed on deep peat moss, not less than fifteen years previous to the date of the Report—The Gold Medal, or Ten Sovereigns.

It being understood that large tracts of peat moss have been profitably planted in England and Holland, it is considered desirable to obtain information on the subject. The premium is strictly applicable to deep peat or flow moss, naturally unmixed with any other substance; and it is desirable that the condition of the moss in its original state, as well as at the date of the Report, should, if possible, be stated.

The Reporter must describe the mode and extent of the drainage, and the effect it has had in the subsiding of the moss; the trenching, levelling, or other preliminary operations that may have been performed on the surface; the mode of planting, kinds and sizes of trees planted, and their relative progress and value, as well as the comparative value of the timber, with that of a similar age and description grown on other soils in the vicinity.

Reports to be lodged by 10th November 1849.

NOTE.—It is understood, that in Holland Ash and Willow are profitably grown in Peat Moss, and cut for barrel hoops every six or seven years. An Honorary Premium will be awarded for satisfactory information in regard to this.

7. FOREST TREES OTHER THAN CONIFERÆ.

For an approved Report on the more extended introduction of hardy, useful, or ornamental Trees, other than Coniferæ, which have not hitherto been generally cultivated in Scotland—The Gold Medal.

The Report should specify, as distinctly as possible, the kinds of trees experimented upon, giving their popular names, or those by which they are known in the nursery gardens, and, when practicable, their scientific or botanical names. The nature of the locality of the plantation should likewise be described, as to soil, exposure, shelter, and elevation above the level of the sea. The adaptation of the trees for use or ornament should be mentioned. Particular attention is directed to the various kinds of American Elms, the Himalayan Oaks, Ashes, and Sycamores; to the *Quercus Mirbeckii* of Algeria, the *Planera Richardi*, and the *Tilia heterophylla*. Attention should also be given to the varieties of the black Italian Poplar, which

affords useful timber for many country purposes. The Beeches of Terra del Fuego, and of the Falkland Islands, as well as the Brown Birch of South America, are still very rare in this country, but well worthy of attention.

Reports to be lodged by 10th November in any year.

8. FENCES.

For an approved Report on Plants other than the Hawthorn—*Cratægus Oxyacantha*, which may be employed for live fences in different soils and situations—The Medium Gold Medal, or Five Sovereigns.

Reports to be lodged by 10th November 1847.

9. RECENTLY INTRODUCED CONIFERÆ.

For an approved Report on the results attending the culture of the recently introduced Coniferous Trees—The Gold or Silver Medal, according to the merits of the communication.

It is the wish of the Society to ascertain how far the various recently introduced kinds of the Pine or Fir Tribe are likely to prove either useful or ornamental trees in the climate of Scotland; such as *Cedrus Deodara*, *Pinus excelsa*, and *Abies Morinda*, from Nepaul; *Abies Douglasii* and *A. Menziesii*, from North West America and California; *Araucaria imbricata*, from Chili; *Cryptomeria Japonica* or Japan Cedar, from Shanghai in China; *Pinus Austriaca*, or Black Pine, and *Pinus Cembra Helvetica*, or Swiss Stone Pine. Information is therefore desired as to the Soils and exposures which seem best adapted for these different species, or as many of them as have been cultivated by the Reporter; also as to the advantage of sheltering any of them while young, by means of Scotch Firs, or Spruces, as nurses. Comparative statements should be given, as far as possible, between their respective progress in growth and that of the more commonly cultivated sorts, such as Scotch Fir, Larch, Spruce, and Silver Fir; and their comparative general qualities, as forest or ornamental trees, should also be mentioned.

Reports to be lodged by 10th November in any year.

10. MORE EXTENDED INTRODUCTION OF KNOWN SPECIES OF THE FIR TRIBE.

To the person who shall, within six years from 1842, inclusive, have introduced from any part of the world, seeds capable of germination, the produce of hardy species of the Fir Tribes which have been already introduced into Britain, but of which only a few plants

have been raised—The Gold or the Silver Medal, or a piece of Plate of such value as the Directors may, in the circumstances of the case, deem adequate.

It is required that the quantity of seeds of each species imported shall be sufficient to afford at least 250 seedling plants; and farther, that before the Premium be awarded, the number of seedling plants of each species actually raised in Scotland, shall not be less than 50. Attention is particularly directed to *Araucaria imbricata, Pinus ponderosa, Lambertiana,* and *Sabiniana*; to *Abies Douglasii, nobilis, grandis,* and *Menziesii*; and to *Taxodium sempervirens,* which last is abundant in the vicinity of St. Francisco, and throughout the low sandy plains of California. Intending Competitors are referred to the Premium No. 17, Essays and Reports, pages xxi. xxii. as to the manner in which seeds ought to be transmitted to this country.

Reports to be lodged by 10th November 1848.

§ III.—WASTE LANDS.

1. IMPROVEMENT OF A SPECIFIED EXTENT OF WASTE LAND BY TILLAGE.

1. To the Proprietor or Tenant in Scotland who shall transmit to the Society an approved Report of having successfully improved, and brought into profitable tillage, within a period of five years immediately preceding the date of his communication, an extent of waste and hitherto uncultivated Land, not being less than fifty acres—The Gold Medal, or Ten Sovereigns.

2. To the Tenant in Scotland who shall transmit to the Society an approved Report of having within the period of three years preceding the date of his Report, successfully improved, and brought into profitable tillage, an extent of waste and hitherto uncultivated Land, not being less than twenty acres on the same farm—The Medium Gold Medal, or Five Sovereigns.

3. To the Tenant who shall transmit an approved Report of a similar improvement of not less than ten acres—The Silver Medal.

The Reports in competition may comprehend such general observations on the Improvement of Waste Lands as the writer's experience may lead him to make; but they are required to refer especially to the land reclaimed, (which, if not in one continuous tract, must be in fields of considerable extent) to the nature

of the soil, the previous state and probable value of the ground, the obstacles opposed to its improvement, the mode of management adopted, and in so far as can be ascertained, the produce and value of the subsequent crops; the land must have borne one crop of grain, at least, previous to the year in which the Report is made. The Reports must be acccompanied by a detailed statement of the expense, and by a certified measurement of the ground. It shall not be competent to include an improvement for which a premium has been awarded, as part of a more extensive improvement, for which a higher premium is subsequently claimed.

Reports to be lodged by 10th November in any year.

2. IMPROVEMENT OF MUIR OR MOSS GROUND BY TOP-DRESSING.

1. To the Proprietor or Tenant in Scotland who shall transmit to the Society an approved Report of having, within the three years immediately preceding the date of his Report, successfully improved the pasturage of not less than thirty acres of Muir or Moss Lands, by means of Top-Dressing without Tillage—The Gold Medal, or Ten Sovereigns.

2. To the Proprietor or Tenant who shall transmit an approved Report of a similar improvement of not less than fifteen acres—The Silver Medal.

The Society has been given to understand, as the result of actual experiment, that a great extent of muir and moss land in Scotland may be converted into, comparatively speaking, superior pasturage, by top-dressing without tillage, and it is, therefore, desirous of encouraging such experiments. Reports must state the particular mode of top-dressing adopted, and the expense per acre, and as many particulars as possible regarding the previous natural products of the soil, the elevation of the ground, and the changes produced by the application of the top-dressing, and also whether, and to what extent, the lands had been at the same time, or previously, drained.

Reports to be lodged by 10th November in any year.

§ IV.—AGRICULTURAL MACHINERY.

1. THE COMPARATIVE ADVANTAGES OF DIFFERENT DESCRIPTIONS OF MACHINES FOR THRASHING GRAIN.

For an approved Report of a series of experiments, properly

authenticated, showing the comparative results of thrashing a given quantity of the same kind and quality of grain by the common Scotch Thrashing Machine, by the Peg Drum Machine; and also, where practicable, by the English High Speed Beater—Twenty Sovereigns.

Each machine employed in the experiments must be fitted with shaking and dressing, or winnowing machinery, so that the grain may be delivered from the machine fit for market. The quantity thrashed in one experiment on each machine is not to be less than five quarters, and the experiment repeated three times, but it is not essential that the kind and quality of the grain be the same for each repetition.

For the convenience of comparison, it is desirable that the *power* employed should in all cases be horses, and the same set in all cases, but if it is found necessary to use steam machines, non-condensing engines should be preferred as being more easily compared—and in such cases the pressure of the steam per square inch in the boiler must be carefully registered, and, if possible, also in the cylinder, by means of the steam indicator. The diameter of the cylinder, length of the stroke of piston, and the number of strokes per minute, to be also noted.

Competitors, in stating their results, are requested to have regard to the quantity of grain thrashed; the time and power employed; the quality of the thrashing, whether clean or foul; the state of the straw, whether it is broken or remaining entire, by comparison from the different machines; and also the condition of the dressed grain, whether any portion of it has been broken or bruised. The average length of straw in the sheaf, and any other particulars that may appear to the experimenter to be of importance, to be also noticed.

Reports to be lodged by 10th November 1847.

2. INVENTION OR IMPROVEMENT OF IMPLEMENTS OF HUSBANDRY.

To the person who shall invent or improve any Instrument or Machine applicable to Husbandry or Rural Economy, which, from its utility in saving labour or expense, simplicity, or cheapness of construction, or other circumstances, shall be deemed by the Society deserving of public notice—The Gold or the Silver Medal, or such sum in money, taking into account the value of the Model, as the communication shall appear to deserve.

The account of the implement should be accompanied by a model, made to a scale of three inches to the foot, which, if approved, will be deposited in the Society's Museum, and the expense incurred by its

construction will be repaid to the Inventor. The model to be formed of wood or metal; and the notice or description transmitted with it must specify, according to the best of the inventor's abilities, the purpose or advantage of his invention or improvement. When machines or models are transmitted, it must be stated whether they have been elsewhere exhibited or described. Models and descriptions may be lodged at any time with the Secretary.

ROCKS, MINES, AND MINERALS.

This section of the Premiums has been suspended, there being in hand a considerable accumulation of unpublished Surveys and Reports.

CLASS B.

CROPS AND CULTURE.

1. SEED FOR CORN AND OTHER CROPS.

The Society, with a view of aiding Local Associations and Individuals in the improvement of the different varieties of Grain, &c., best adapted for their respective localities, offers annually in six districts, the Silver Medal to the grower of the best and approved parcel of each of the following Seeds, for which premiums in money are awarded in the districts.

1. Any variety of White Seed Wheat.
2. Red Seed Wheat.
3. Chevalier Barley.
4. Any other variety of Seed Barley.
5. Potato Oats.
6. Hopetoun Oats.
7. Any other variety of Early Seed Oats.
8. Any variety of Late Seed Oats.
9. Any variety of Field Bean.
10. Any variety of Early Field Peas.
11. Any variety of Late Field Peas.
12. Common Tares or Vetches.
13. Perennial Rye Grass Seed.
14. Timothy Grass Seed.
15. Any variety of Potato.

PREMIUMS WILL BE GIVEN IN THE FOLLOWING DISTRICTS:—

I. County of NAIRN: Convener, James Campbell Brodie, Esq., of Lethen, for the best and approved parcels of—

1. Any variety of White Seed Wheat.
2. Any variety of Seed Barley.
3. Any variety of Early Seed Oats.
4. Any variety of Late Seed Oats.
5. Perennial Rye Grass Seed.

II. DALKEITH: Convener, Robert Scott Moncrieff, Esq., for the best and approved parcels of—

1. Potato Oats.
2. Hopetoun Oats.
3. Barbachlaw Oats.
4. Dun Oats.
5. Any other variety of Early Seed Oats.
6. Any other variety of Late Seed Oats.
7. Chevalier Barley.
8. Any other variety of Seed Barley.
9. Hunter's Wheat—crop 1846.
10. Hunter's Wheat—crop 1847.
11. White Seed Wheat—1847.
12. Red Seed Wheat—1847.

III. County of RENFREW: Convener, Colonel Macdowall of Garthland, for the best and approved parcels of—

1. Any variety of White Seed Wheat.
2. Early Seed Oats.
3. Perennial Rye Grass Seed.

IV. Counties of DUMFRIES and KIRKCUDBRIGHT: Convener, James Macalpine Leny, Esq. of Dalswinton, for the best and approved parcels of—

1. Any variety of White Seed Wheat.
2. Any variety of Seed Barley.
3. Potato Oats.
4. Sandy Oats.
5. Any other variety of Early Seed Oats.
6. Any other variety Late Seed Oats.
7. Perennial Rye Grass Seed.
8. Any variety of Potato.

V. District of KINTYRE: Convener, Smollett Montgomery Eddington, Esq., of Glencreggan, for the best and approved parcels of—

1. Sandy Oats.
2. Bere.
3. Any variety of Beans.

VI. District of MOULIN, BLAIR, LOGIERAIT, and Part of DULL: Convener, Archibald Butter, Esq., of Faskally, for the best and approved parcels of—

1. Oats.
2. Barley.

CONDITIONS.

1. Local Associations and individuals intending to institute competitions for any of the above medals, to lodge with the Secretary of the Society a statement of the different descriptions of seeds intended to be competed for, with a satisfactory guarantee that Money Premiums shall be given to the extent of not less than £2 sterling for each variety of such seeds.

2. In each District a Convener, to be appointed by the Society, with the aid of the other Members of the Society in the District, and of the Local Association or Individual contributing the Money Premiums, will fix the time and place of Competition, appoint the Judges, and make all other necessary arrangements.

3. The quantity shown in Competition by each grower must not be less than three quarters of each variety of grain, two quarters of Beans, Peas, Vetches, and Grass Seeds, and half a ton of Potatoes.

4. The Judges shall be guided in their awards—1st, By the purity of the Seed;—2d, By its freeness from extraneous Seeds;—and 3d, Where there is an equality in these respects, by the weight.

5. Each Competitor to whom a medal shall be adjudged, must, immediately after his preference is declared, transmit to the Society's Museum, free of expense, a sample of the seed for which the medal shall have been awarded; and when the seed consists of grain or grass seed, the quantity to be transmitted is not to be less than two quarts.

6. The Conveners in the Districts in which Competitions are to be held, will be furnished with blank schedules for making up returns of the awards of the Judges, which must be returned to the Secretary within fifteen days after the Competitions.

7. The returns must show, as accurately as possible, the quantity of produce per imperial acre, as also the altitude, exposure, and nature of the soil on which the crops were raised, together with the dates of sowing and reaping, and, in the case of grain or grass seed, the weight per bushel. The varieties, for which premiums have been given, must be named.

8. Schedules, containing returns of Competitions, must, at latest, reach the Secretary by the 10th November in the year in which the Competitions take place.

Applications from any of the above districts which may desire to have the Premiums continued for another year, or from other districts which have not already had the Premiums, to be lodged with the Secretary of the Society by 10th of November next. The Directors will select from the applications the six Districts for 1848.

2. TURNIP SEED.

1st, Yellow Field Turnip.

District—The Counties of Aberdeen and Kincardine.

To the person in the Counties of Aberdeen and Kincardine, who shall, in the year 1848, have grown a quantity of not less than ten quarters of the most approved quality of seed of any variety of Yellow Field Turnip (Swedes excepted,) from the best and purest approved stock of mature selected and transplanted bulbs, or from turnips produced from the seed of bulbs which shall have been so selected and transplanted—The Gold Medal, or Ten Sovereigns.

2d, White Globe Turnip.

District—The County of Dumfries.

To the person in the County of Dumfries who shall, in the year 1848, have grown a quantity of not less than ten quarters of the most approved quality of seed of any variety of White Globe Turnip, from the best and purest approved stock of mature selected and transplanted bulbs, or from turnips produced from the seed of bulbs, which shall have been so selected and transplanted—The Gold Medal, or Ten Sovereigns.

The above Premiums are offered, with the view of directing attention to, and encouraging the more careful growth of turnip seeds from selected and transplanted stocks.

Competitors must lodge intimation of their intention to compete, with the Secretary, on or before the 1st of December next, so as to admit of an inspection of the growing crops being made by persons appointed by the Society, who will be guided in their opinions,

1st, By the purity of the stock.
2nd, By the symmetry of the form.
3d, By the apparent hardiness of the variety.
4th, By its apparent capability of yielding a bulky or heavy crop.

When the turnips, intended for seed, are at maturity, twenty plants must be sent, free of charge, to the Society's Museum, in 1847.

A certified statement of the extent of ground under crop, and of the quantity of clean marketable seed harvested, must be lodged with the Secretary on or before the 10th of November 1848, and at same time, a sample of not less than two quarts of the seed must be transmitted, free of charge, to the Museum.

3. GREEN CROPS ON HILL FARMS.

The Society, with the view of aiding Local Associations in their efforts for improving the management of Turnip and Potato Cultivation on *Hill Farms*, which has been represented as being still extremely defective in several districts, offers the following Premiums for Competition in 1847, the one-half of the amount to be contributed by each District claiming the Premiums.

For the best managed Crop of Potatoes or Turnips in respect to the cleaning of the land, and the general good working of the Crop—Three Sovereigns.

For the second best ditto—Two Sovereigns.

For the third best ditto—One Sovereign.

Application has been made for these Premiums in 1847 by
The Glenkens Agricultural Society, Stewartry of Kirkcudbright—Convener, William Scot, Esq. of Craigmuie.

CONDITIONS.

1. The proportion of Green Crop, of Turnip, and Potato, shall be one-third of the land on the farm, which shall be ploughed that year.

2. The minimum extent of land under green crop, as above, shall be six imperial acres.

3. The proportion of Turnip shall be at least one-fourth of the green crop as above.

4. The whole land of the farm under green crop shall be shown in competition.

5. Applications by Local Associations, accompanied by guarantees for payment of one-half of the amount of the Premiums, to be lodged with the Secretary of the Society on or before the 1st day of May in each year.

6. The names of intending Competitors to be intimated to the Conveners to be appointed by the Society on or before the 15th day of May in each year; and it shall then be competent to the Convener to add such others to the List as he may think deserving of encouragement; but after that day no additional name shall be received.

7. There must not be fewer than two Competitors in each District; and the Convener and Committee shall have power to withhold the Premiums, or divide them in such manner as they shall consider most equitable. The gainer of the first Premium to be precluded from competing in the subsequent year. In the event of there being only one Competitor, it will be in the power of the Committee to vote a portion of one of the Premiums, if his merits shall appear to be such as to deserve it.

8. The Inspectors to be fixed by the respective Conveners shall decide the Premiums, with the assistance of such other Members of the Society as may attend.

The awards to be made and intimated to the Secretary of the Society on or before the 1st of December in each year; and Conveners are particularly requested to state in their reports the proportion of each lot cropped, as above-mentioned, and to offer any suggestions which they may consider of importance.

4. PREMIUMS FOR GREEN CROPS ON SMALL POSSESSIONS.

The Society, with the view of improving the cultivation of small possessions, by the introduction of Green Crops, will give the following Premiums in the Districts after-mentioned, viz.:

The PARISHES OF KENMORE AND KILLIN, including the portion of the parish of WEEM on LOCH TAYSIDE.—Convener, the Marquis of Breadalbane.

The DISTRICT OF GLENKENS, Stewartry of Kirkcudbright.—Convener, W. G. Yorstoun, Esq. of Garroch.

The ISLANDS OF ORKNEY.—Convener, William Balfour, Esq., Birston Brae.

The ISLAND OF SKYE.—Conveners, Lord Macdonald and Norman Macleod, Esq. of Macleod; in their absence, their Factors are authorized to act.

The PARISHES OF FETTERCAIRN, FORDOUN, AND MARYKIRK, County of Kincardine.—Convener, Sir John S. Forbes, Bart.

PREMIUMS.

For the best and approved Green Crop—Three Sovereigns.
For the second best do.—Two and a-half Sovereigns.
For the third best do.—One and a-half Sovereign.
For the fourth best do.—One Sovereign.

CONDITIONS.

1. The Competition to be limited to Tenants occupying not more than 40 acres of land.

2. The quantity of ground under Green Crop to be fixed by the Convener,—at least one-half of the Green Crop to be Turnips, and that portion which is in Green Crop in 1847 must be sown out, with sufficient quantities of Clovers and Rye Grass, with the White Crop in 1848.

3. The names of intending Competitors to be intimated to the Conveners appointed by the Society, on or before the 15th day of May 1847; but after that day no additional name shall be received.

4. There must not be fewer than two Competitors in each District; and the Convener and Committee shall have power to withhold the Premiums, or divide them in such manner as they shall consider most equitable. The gainer of the first Premium to be precluded from competing in subsequent years. In the event of there being only one Competitor, it shall be in the power of the Committee to vote a portion of one of the Premiums, if his merits shall appear to be such as to deserve it.

5. The Inspectors to be fixed by the respective Conveners, who, with the assistance of such other Members of the Society as may attend, shall decide the Premiums.

The awards to be intimated to the Secretary of the Society on or before the 1st of December in each year; and Conveners are particularly requested to state in their reports the proportion of each lot cropped, as above-mentioned, and to offer any suggestions which they may consider of importance.

Similar Premiums will be given in four additional Parishes in the year 1848, and three succeeding years, on guarantees for the payment of one-half of the Premiums being lodged with the Secretary on or before the 1st of October 1847.

5. PLOUGHING COMPETITIONS.

The Silver Medal will be given to Ploughmen who carry the first Money Premium at Competitions, instituted by resident Gentlemen or Local Farming Societies, provided that not fewer than fifteen Ploughs shall have started, and that Premiums to the amount of Three Sovereigns shall have been awarded. To authorize the issue of the Medal, a Report, in the following terms, must be made to the Secretary, within three months of the date of the Competition, by one or more Members of the Society who shall have attended it.

I of Member of the Highland and Agricultural Society, hereby certify that I attended a ploughing competition at on the when ploughs competed; of land was assigned to each, and hours were allowed for the execution of the work. The sum of £ was awarded in the following proportions, viz.:

[Here enumerate the names and designations of successful competitors.]

NOTE.—In estimating the work of Competitors, attention should be directed to its sufficiency below, as well as to its neatness above, the surface.

On land of average tenacity, the rate of ploughing should be not less than will turn over an imperial acre in ten hours.

NOTE.—The Society being anxious to co-operate with, and encourage Local Associations in their efforts to promote improvement, will give a limited number of Medals annually, in addition to the Money Premiums which may be awarded in the Districts.

1. For the best managed Green Crop on a farm, in any district.
2. For the best kept Fences on a Farm in any district.
3. For the greatest extent of Land, in proportion to the size of the Farm, subsoiled or trench ploughed, by a tenant in any district.

The medals to be issued will be limited to ten in each class. Applications for 1848 must be lodged by 10th November next, accompanied with a guarantee, that in addition to the Medal, a premium of not less than £5 will be given by the district applying.

CLASS C.

LIVE STOCK—DISTRICT COMPETITIONS.

§ I. CATTLE.

PREMIUMS FOR IMPROVING THE BREED OF CATTLE IN THE FOLLOWING DISTRICTS.

1. *The District of Lorn, Argyllshire, comprehending the country from Kilmelford to Lochaw, by Lochavich, and the Water of Avich; from thence by Lochaw to the Water of Tettle, including the country of Glenorchy to the head of Lochleven; and from thence to Linealich by the Sound of Corryvreckan to Lochmelford.*
2. *The Parishes of Auchterarder, Blackford, Muthil, Comrie, Monzie-vaird and Strowan, Crieff, Monzie, Fowlis Wester, Maderty and Trinity Gask, in the county of Perth.*
3. *The District in the West of Perthshire, comprehending the Parishes of Callendar, Kilmadock, Kincardine, Comrie, Balquhidder, Aberfoyle, and Port of Monteith, with that part of the District of Breadalbane comprising Glenlochy, Glendochart, and Glenfalloch.*
4. *The District of Kintyre to the south of the Lands of Skipness, and adjoining the District of Argyll, as after described.*
5. *The District of Mull and Morven, Argyllshire, comprehending the Islands of Mull, Ulva, Icolmkill, Tyrie, Coll, Inchkenneth, Gometra, and small Isles adjacent, the Parish of Morven, and Lands of Kingerloch.*
6. *The Counties of Moray and Nairn.*
7. *The Island of Skye.*

CLASS I.

1. For the best Bull, above two and under eight years old, to be exhibited at the Competition in the Districts above described, *bona fide* the property of a Proprietor, Factor, or Tenant, and kept in his possession from the 20th day of May preceding the Competition—The Honorary Silver Medal.

2. For the best Bull, above two and under eight years old, *bona fide* the property, and in the possession of any Tenant, or Proprietor farming the whole of his own lands, in the said Districts, kept within the District, from the 20th day of May preceding the Competition—Ten Sovereigns.

3. For the second best Bull, of the same age, the property, and in the possession of any Tenant, or Proprietor farming the whole of own lands, in the said Districts, and kept on his farm, within the District, for the aforesaid period—Five Sovereigns.

Class II.

1. For the best two Queys of two years old, the property of, and bred by, any Tenant, or Proprietor farming the whole of his own lands, in the said Districts above described—Five Sovereigns.

2. For the second best two Queys of two years old, the property of, and bred by, any Tenant, or Proprietor farming the whole of his own lands, in the said Districts—Three Sovereigns.

Note.—The Society gives the Premiums for three Competitions in alternate years; and provided the gentlemen of the District, or any Local Association therein, shall have continued the Competitions, and have awarded and duly reported Premiums in the District to an amount not less than one-half of the Society's Premiums, and for the same descriptions of Stock, during the two intermediate years, the Society continues its Premiums to the District for an additional year. By this arrangement, each District may have the benefit of six Competitions.

In 1847,

Competitions will take place—

In No. 1, for the fourth or additional year.
No. 2, for the third year.
Nos. 3 and 4, for the first year.
Nos. 5, 6, and 7, local Competitions will be held.

In 1848,

In No. 2, for the fourth or additional year.
Nos. 3 and 4, the local Competitions will be held.
Nos. 5, 6, and 7, for the second year.

Conveners of Committees.

For the First District—The Marquis of Breadalbane; in his absence, Dugald Macdougall, Esq. of Gallanach; three Members of Committee to be a quorum.

For the Second District—The Viscount Strathallan; in his absence, John Stewart Hepburn, Esq. of Colquhalzie; three Members to be a quorum.

For the Third District—John Burn Murdoch, Esq. of Gartincaber; three Members to be a quorum.

For the Fourth District—Richard Campbell, Esq. of Auchinbreck; three Members to be a quorum.

For the Fifth District—Francis William Clark, Esq. of Ulva, and Murdoch Maclaine, Esq. of Lochbuy; three Members to be a quorum.

For the Sixth District—Charles Lennox Cumming Bruce, Esq. of Roseisle; in his absence, Robert Grant, Esq. of Kincorth; three Members to be a quorum.

For the Seventh District—Lord Macdonald and Norman M'Leod, Esq. of Macleod; three Members to be a quorum.

RULES OF COMPETITION.

1. The Members of the Society resident in, or connected by property with, the respective Districts, are hereby appointed Committees of Superintendence for regulating the Competitions in their several Districts.

2. The Convener or Conveners of each District, in which the Premiums are this year in competition, will summon a meeting of the Society's Members connected with the Districts, to be held at such time and place as the Convener may appoint, not being later than the 20th of May, for the purpose of fixing the time of competition (and also the place of competition, when not already fixed,) and of naming a Sub Committee for making all necessary preparatory arrangements for the Show,—including the nomination of Judges; and of giving due intimation, as after directed, of the time and place of Competition. The Meetings must be attended by the prescribed quorum, and are open to all Members of the Society.

3. Conveners, with the approbation of a quorum of the Committees, are respectively authorized, in such cases as they shall see proper, to divide the two Premiums allowed for Bulls into three Premiums,—the first Premium not being less than Eight Sovereigns; and, in like manner, to divide the sums allowed for Queys into three Premiums, fixing their amount.

4. The Committee shall not place for Competition any Stock which, in their opinion, does not fall within the regulations prescribed, or does not possess merit; and in no instance shall any of the Money Premiums be awarded where there are not, after such selection, at least three Competitors. The Committee are, however, authorized, in case of deficiency in the required number of Competitors, to make an allowance to a party showing stock of merit, not exceeding half the amount of the Premium.

5. The times and also the places of Competition are to be fixed by the Conveners, with the advice of at least a quorum of their respective Committees, except in the 1st District, in which Oban, and in the 6th, in which Elgin and Forres (alternately) are fixed. The Competitions for the Society's and for the District Premiums are to take place between the 1st of June and 1st of November next. In the 1st, 5th, and 7th Districts, preference must be given to Cattle of the Highland Breed.

6. The Conveners will be particularly careful, that the times and places of Competition are intimated throughout their several Districts, two weeks, at least, previously to the days appointed for the Competitions, in such manner as shall be deemed most effectual for communicating the information to all persons interested; and the modes of intimation which may be adopted in the different Districts, as well as the periods of announcement, must be stated in the Reports of the Competitions.

7. The Society does not admit an animal, in any Class of Stock, which has gained the Society's first Premium at a District or General Show in a former year, to be again shown in Competition in any District; and for no description of Stock shall either the same or a lower denomination of Premium be awarded, in the District in which it has already gained a Premium.

8. The same person shall not obtain more than one Money Premium for Bulls, and one for Queys; but a Tenant may, with different Bulls, carry both the Medal and the Money Premium. A Tenant entering one Bull may compete either for the Medal or Money Premium.

9. The Directors have deemed it expedient to exclude Proprietors, and Factors named on the Committee, or acting in the absence of Proprietors, from competing for the *Money Premiums;* but being fully impressed with the advantages of having their Stock exhibited at the District Shows, they have offered the Honorary Silver Medal for the best Bull, whether the property of one of the parties aforesaid, or of a Tenant, if superior to the Bull to which the highest Money Premium is awarded.

10. A Bull which has gained the Medal, will be allowed to compete, in a future year for the Money Premiums, when, *bona fide*, the property, and in the possession of a Tenant not the gainer of the Medal, provided it shall have continued the property of the latter for, at least, one year after the award of the Medal, and has afterwards been the Tenant's property, and in his possession from the day fixed by the Regulations—the 20th of May preceding the Competition. A Bull which may have been purchased by two or more tenants, for the use of their Stocks, will be allowed to compete, although the exhibitors may not be joint tenants. Purity of breed is to be taken into account in awarding the Premiums.

11. Bulls, for which the Money Premiums are awarded, must have served, or shall be kept to serve in the District at least one season; and the rate of service may be fixed by the Committee.

12. Committees are recommended to take the assistance of practical men in awarding the Premiums. No Member of Committee showing Stock of his own shall act as a Judge.

13. Blank Reports and Returns, specifying, when completed, the particulars of the Competitions, will be forwarded to the Conveners of the different districts. To entitle Competitors to their Premiums these must, in all details, be carefully filled up, and signed by a majority of the Committee who attend the Competition, and lodged with the Secretary on or before the 10th of December next.

14. It is to be distinctly understood, that in no instance does any claim lie against the Society for expenses attending a Show of Stock, beyond the amount of the Premiums offered; and that all Premiums not applied for within two years from the time they are payable, shall be forfeited.

15. A Report of the Competition and Premiums awarded at the *intermediate* Local Shows, in the several districts, signed by at least two Members of the Society, must be transmitted to the Secretary of the Society, on or before the 10th December in each year, in order to entitle the Districts to any claim for the additional year's Premiums.

§ II. HORSES.

PREMIUMS FOR IMPROVING THE BREED OF DRAUGHT HORSES.

DISTRICT.

Dumfries-shire, and the Stewartry of Kirkcudbright.

Forty-five Sovereigns, of which twenty are contributed by the

Dumfries and Kirkcudbright Agricultural Society, will be awarded as follows:

1. For the best Stallion, for the improvement of the breed of Draught Horses, not under three years and nine months, and not above twelve years old—Twenty-five Sovereigns.

2. For the second-best Do.—Twenty Sovereigns.

Convener of Committee.

Marmaduke Constable Maxwell, Esq., of Terregles; three Members a quorum.

RULES OF COMPETITION.

1. The Members of the Society in the District are hereby appointed a Committee of Superintendence, as in No. 1 of the Regulations for the Cattle Competitions; and they will be convened on or before the 10th of March, in the same manner, and for purposes similar indicated in the said Regulations.'

2. The time and place of Competition for the Premiums to be fixed by the Convener, with the concurrence of at least a quorum of the Committee, and to be published by him in due time, and in such manner as shall be thought by the Committee most effectual for the information of those interested.

3. The Competition will take place betwixt 20th March and 1st May 1847. The Regulations for Cattle Shows, in regard to the previous intimation to the Committee and Competitors—the recommendation to the Committee to take the assistance of practical men as Judges—the power of the Committee to exclude stock, if the animals produced shall be of inferior character, and, in certain circumstances, to make an allowance for stock of merit—those relating to extra expenses, and against Competitors being also Judges—the period within which premiums must be applied for—and the manner in which the Report is to be certified and transmitted to the Society, are severally hereby declared applicable to the Premiums for Horses. Evidence must be produced that the Prize Stallions have had produce.

4. One of the Prize Stallions shall serve within the County of Dumfries, and the other within the Stewartry of Kirkcudbright, on such terms and conditions as the Committee shall determine,—the owner of the best animal having a right to name the District within which his Horse shall serve.

§ III. SHEEP.

1. PREMIUMS FOR IMPROVING THE BREED OF SHEEP.

I. LEICESTER BREED.

DISTRICTS.

1. *A District round Dalkeith, comprehending the Lothians and adjoining parts of Berwickshire.*

2. *A District round Kelso, comprehending Roxburghshire and the lower parts of Berwickshire, commonly termed the Merse, with the Parishes of Mertoun and others to the west.*

In 1847,

Local Competitions will be held in the above Districts, when premiums to the amount of £11, 10s., or one-half of the sum given by the Society, should be awarded.

In 1848,

In No. 1, for the third year of the Society's Premiums.
No. 2, for the second year of the Society's Premiums.

NOTE.—The Premiums for Leicester Sheep Competitions will in future be reduced from £30 to £23.

Conveners of Committees.

FOR THE FIRST DISTRICT.—The Duke of Buccleuch; in his absence, Robert Scott Moncrieff, Esq.; five Members a quorum.

FOR THE SECOND DISTRICT.—The Duke of Roxburghe; in his absence, Sir John Pringle of Stitchell, Bart.; five Members a quorum.

II. CHEVIOT BREED.

1. *The District round Hawick.*
2. *The Parishes of Selkirk, Ettrick, Yarrow, Inverleithen, Stow, Galashiels, Ashkirk, and Roberton.*
3. *The County of Sutherland, and the Parishes of Reay and Latheron, in the County of Caithness.*

PREMIUMS IN EACH OF THE SAID DISTRICTS.

1. For the best Tup of any age, the property of the Competitor, which shall have served in the District the preceding season, or which shall so serve the season following the Competition—Five Sovereigns.

2. For the best Three Shearling Tups, the property of, and bred by the Competitor—Five Sovereigns.

3. For the best Pen of Five Ewes, not less than Two Shear, the property of the Competitor—Five Sovereigns.

4. For the best Pen of Five Gimmers or Shearling Ewes, the property of, and bred by the Competitor—Four Sovereigns.

In 1847,

Competitions will take place

In No. 1. For the fourth or additional year.
No. 2. For the first year of the Society's Premiums.
No. 3. The local Competition will be held.

In 1848,

No. 2. The local Competition will be held.

No. 3. For the second year.

NOTE.—The Premiums for Cheviot Sheep are reduced as above to £19. But the former Premiums, amounting to £24, will be allowed this year on the 1st District, half of that sum having been awarded at its three intermediate Shows.

Conveners of Committees.

FOR THE FIRST DISTRICT.—Allan Elliot Lockhart, Esq. of Cleghorn, three Members a quorum.

FOR THE SECOND DISTRICT.—Alexander Pringle, Esq. of Whytbank; three Members a quorum.

FOR THE THIRD DISTRICT.—The Duke of Sutherland; in his absence, George Dempster, Esq., of Skibo; three Members a quorum.

III. BLACK-FACED BREED.

DISTRICTS.

1. *The District accessible to Killin, in Breadalbane.*
2. *A District round Fort-William, comprehending the portions of the Counties of Inverness, Argyle, and Perth, having convenient access to the place of competition.*
3. *The District of Argyle, together with the parishes of North and South Knapdale, and Kilberry, and the lands of Stonefield and Skipness.*
4. *The Island of Arran.*

PREMIUMS IN EACH OF THE SAID DISTRICTS.

1. For the best Five Tups, not exceeding four Shear, the property of any proprietor, or of any Tenant in the District paying more than £150 of yearly rent, which shall have served in the District the season preceding, or shall so serve the season following the Competition—Five Sovereigns.

2. For the best Five Tups, not exceeding four Shear, the property of any Tenant in the District paying not more than £150 of rent—Five Sovereigns.

3. For the best Pen of Ten Gimmers or Shearling Ewes, belonging to any proprietor, or to any Tenant in the District paying more than £150 of rent, and which shall be certified at the Com-

petition to have been at least one year in his possession—Four Sovereigns.

4. For the best Pen of Ten Gimmers or Shearling Ewes, under the same condition, but being the property of a Tenant in the District paying not more than £150 of rent—Four Sovereigns.

In 1847,

Competitions will take place

In No. 1. For the fourth or additional year.
No. 2. for the third year.
No. 3. for the first year.
No. 4. The local Competition will be held.

In 1848,

No. 2. Not having reported intermediate local Competitions in terms of the Regulations, loses right to the additional Premiums.
No. 3. The local Competition will be held.
No 4. For the second year.

The Premiums for Black-faced Sheep are reduced as above to £18, except in No. 1., where £24 is this year allowed, half of that sum having been awarded at each of its intermediate Competitions.

Conveners of Committees.

For the First District.—The Marquis of Breadalbane; in his absence, Sir Robert Menzies of Menzies, Bart.; five Members a quorum.

For the Second District.—Lord Ward and Colonel Maclean of Ardgour; three Members a quorum.

For the Third District.—John Campbell, Esq., of Stonefield; three Members a quorum.

For the Fourth District.—The Marquis of Douglas; in his absence, John Paterson, Esq.; three Members a quorum.

CONDITIONS AND RULES OF COMPETITION.

1. The Members of the Society in the several Districts are hereby appointed Committees of Superintendence, as in No. 1. of the Regulations for the Cattle Competitions; and they will be convened by their several Conveners on or before the 10th of May, in the same manner, and for purposes similar to those indicated in the said Regulations.

2. The Meetings of the Committee of Superintendence, and attendance at Competitions for Premiums, to be open to all Members of the Society; and not fewer than the prescribed quorum of the Committee to be present.

3. The boundaries of the Districts are very generally expressed, to enable Competitors to send Sheep to the Exhibition, who are within an attainable distance. The same Sheep, however, cannot draw Premiums in more than one District in the same

season. All Ewes in Competition, except Shearling Ewes, must have reared Lambs the same season.

4. The Competitions in 1847 will take place on such days between the 1st of June and 1st of November as shall be fixed by the Committee.

5. It is recommended to the Committee, as in the case of Cattle Competitions, to take the assistance of practical men as Judges in awarding the Premiums. The Judges, in deciding the Premiums for Sheep, will have regard both to the wool and carcass of the animal. The regulations for Cattle Shows, in regard to the previous intimations to Judges and Competitors—the placing of the stock, and the number of Competitors required for Competition—the power provisionally granted to make an allowance for Stock of merit in the event of deficiency in number, and prohibiting Members acting as Judges who are also Competitors—the regulations relating to extra expenses—the period within which Premiums must be applied for—and the manner in which the Reports are to be certified and transmitted, are severally hereby declared to be applicable to the Premiums for Sheep.

6. The Society gives these Premiums in alternate years for three Competitions in each District; and provided, during the intervening years, they are continued in the District, and Premiums are awarded by Proprietors or Local Societies, and duly reported to the Society, to an amount not less than one-half of the Society's Premiums, and for the same descriptions of Stock, the Society will continue its Premiums to the District for an additional year, thus affording to the Districts the benefit of six continuous Exhibitions.

7. Blank Reports and Returns of Competitions will be furnished to Conveners of Districts. These must be accurately filled up in all details, signed by a majority of the members who were present, and transmitted to the Secretary by the 10th of December.

II. SHEARING SHEEP.

With a view to promote improvement in the Shearing of Sheep, the Silver Medal will be given to the best Sheep-shearer in each of the Districts in which the Society's or Local Premiums for Sheep are in operation.

CONDITIONS.

1. Local Associations, or others who propose to claim these Medals, must, on or before the 20th May 1847, lodge with the Society's Secretary a satisfactory guarantee that Money Premiums will be awarded at each Competition to the amount of not less than £2.

2. The District Conveners for the Sheep Premiums, with the aid of their Committees, shall fix the time and place of Competition, and make all necessary arrangements.

3. The Medal shall not be awarded in any case where there are fewer than four Competitors; and it shall always accompany the highest Money Premium. The Sheep shall be divided into lots of six, distinguished by numbers, and the lot to be shorn by each Competitor shall be determined by the number he draws. The whole shall commence on a given signal, a person being appointed to note the time at which each competitor finishes his task. The Judges shall examine each lot in their separate pens; and if two or more lots appear to be equally well executed, preference shall be given to that executed within the shortest time.

4. The Conveners shall report the particulars of the Competition, and the award of the Judges, to the Society, along with the Report of the award of the Sheep Premiums in the District.

§ IV. SWINE.

PREMIUMS FOR IMPROVING THE BREED OF SWINE.

DISTRICT.

Islands of Orkney.

1. For the best Boar, not under twelve months, and not exceeding four years old, *bona fide* the property, and in possession of any Proprietor or Tenant in the said District, in autumn 1847—Five Sovereigns.
2. For the second best—Three Sovereigns.
3. For the best Breeding Sow of the same age—Four Sovereigns.
4. For the second best—Two Sovereigns.

Robert Scarth, Esq. of Scarth; in his absence, William Balfour, Esq., Birston Brae, to be Convener.

These Premiums to be awarded for animals that are considered most profitable, and best suited for the purpose of curing mess Pork. Attention is recommended to the introduction of the Berkshire or Suffolk breed of Swine.

It is a condition of the offer of the Premiums that Five Sovereigns shall be contributed by the District.

The Competition will be held at Kirkwall, at such time as the Society's Members resident in the District shall fix, at a meeting to be called by the Convener for the purpose, on or before the 1st of June. This meeting is also authorized to name a Committee for managing all details, and to fix the necessary regulations for competition. A Report of the award of the Premiums, with a copy of the Regulations of Competition, to be transmitted to the Secretary, on or before the 10th of December 1847.

CLASS D.

DAIRY PRODUCE.

DISTRICT.

The Parishes of Dunblane, Kilmadock, Kincardine, Lecropt, Muthil, Blackford, Port of Monteith, and Aberfoyle.

The following Premiums are offered in the above District in 1847 and 1848, the Competitions to take place at Dunblane—Twelve Sovereigns in part of the Premiums being contributed by the District.

John Stirling, Esq., of Kippendavie, Convener of Committee.

I. CURING BUTTER.

To the owner of any Dairy in the said District who shall make and cure the best quality of Butter for the market, not being less than one cwt., (112 lbs. the cwt., and 16 oz. the lb.,) during the season 1847—Six Sovereigns.

2. For the second best quality as aforesaid—Four Sovereigns.
3. For the third best quality as aforesaid—Three Sovereigns.
4. For the fourth best quality as aforesaid—Two Sovereigns.

II. MAKING CHEESE.

1. To the owner of any Dairy in said District who shall make for sale, and exhibit the best quality of Cheese from Sweet or Full Milk, the quantity made not being less than two cwt.—Five Sovereigns.

For the second best quality of ditto—Three Sovereigns.

For the third best quality of ditto—One Sovereign.

CONDITIONS.

1. The Members of the Society, resident within the District, are appointed a Committee of Superintendence, for the purposes expressed in the Regulations for Cattle Competitions.

2. The Butter must be certified to have been made and cured on the Competitor's farm during the season 1847, and the whole quantity produced at the Competition must not be less than one cwt. The certificate must be supported by the declaration of the Exhibitor. The Butter shall be inspected by a Committee of the Members of the Society resident within the district. The Committee, at a meeting to be called by the Convener for that purpose, shall fix such general regulations as they may consider proper; and they will, in particular, fix the day of Competition. The quality of the Butter to be tested by judges to be named by the Committee, in the way usually done by purchasers in the public market. In the event of two or more competing lots being deemed equal in quality, the Premium will be awarded to the Competitor who shall have cured the larger quantity. Although not required as a condition, it is strongly recommended as affording facilities for sales, that the Butter should be packed in firkins containing 56 lb. each, or in earthen vessels which have not been glazed with preparations of lead, and of such size as may be suitable for sales. It is also suggested that the vessels containing the samples of Butter, should be of such form as to admit of their contents being easily turned out for inspection. The successful candidates, before receiving the Premiums, are required to transmit to the Secretary a detailed report of the whole process followed by them in the manufacture of their Butter.

3. It must be certified that the Cheese has been made on the Competitor's farm in 1847; and that the sample produced is a fair average specimen of the produce of the Dairy in that year. The conditions as to the general arrangements, time of Competition, and other particulars, to be the same as those above provided in regard to the Butter Premiums, in so far as these are applicable.

A Report of the award of the Premiums to be lodged with the Secretary of the Society on or before the 10th December 1847.

CLASS E.

COTTAGES.

1. PREMIUMS FOR THE BEST KEPT COTTAGES AND GARDENS.

In order to encourage Cottagers to keep their cottages and gardens neat and clean, the following Premiums will be given in the parishes after mentioned. One-half of the Premiums is given by the Society, and the other half is contributed by the Members, or others, who applied for the Premiums.

PREMIUMS.

1. For the best kept Cottage in each of the said Parishes—Two Sovereigns; and in addition, where there shall not be fewer than five Competitors—The Cottage Medal.
2. For the second best kept ditto—One Sovereign.
3. For the best kept Cottage Garden in each parish—One Sovereign.

PARISHES.

Mid-Lothian.

1843—Parish of Newton.—Convener, John Wauchope, Esq. of Edmonstone.

1845—Parish of Penicuick.—Convener, Hugh H. Brown, Esq. of Newhall.

1847—Parish of Lasswade.—Convener, John Cameron, Esq., of Glenesk.

1847—Parish of Inveresk.—Convener, Archibald Hope, Esq., younger of Pinkie.

1847—Parish of Midcalder.—Convener, the Honourable the Master of Torphichen.

Stewartry of Kirkcudbright.

1844—Parish of Carsphairn.—Convener, Colonel the Hon. Frederick Macadam Cathcart of Craigengillan.

1844—Parish of Kells.—Convener, William Grierson Yorstoun, Esq. of Garroch.

1844—Parish of Crossmichael.—Convener, John Hall, Esq. of Mollance.

County of Berwick.

1844—Parish of Fogo.—Convener, Richard Trotter, Esq. of Mortonhall.

1845—PARISH OF POLWARTH.—Convener, Sir H. Hume Campbell, Bart., M.P.

1847—PARISH OF COLDINGHAM.—Convener, John Dickson, Esq. of Peelwalls.

1847—PARISH OF COLDSTREAM.—Convener, Rev. Thomas Smith Goldie.

1847—PARISH OF EYEMOUTH.—Convener, James Renton, Esq. of Highlaws.

1847—PARISH OF FOULDEN.—Convener, Edward Makins, Esq. Auchincraw Mains.

1847—PARISH OF CHIRNSIDE.—Convener, John Wilkie, Esq. of Foulden.

1847—PARISH OF AYTON.—Convener, James Bishop, Esq. Restonhill.

1847—PARISH OF HUTTON.—Convener, George Jeffreys, Esq. of Sunwick.

County of Renfrew.

1846—PARISH OF ERSKINE.—Convener, John Hall Maxwell, Esq. younger of Dargavel.

1846—PARISH OF INCHINNAN.—Convener, John Henderson, Esq. of Park.

County of Perth.

1847—PARISH OF MOULIN.—Convener, Archibald Butter, Esq. of Faskally.

County of Ayr.

1847—PARISH OF DALRYMPLE.—Convener, Thomas Campbell, Esq. Cassilis House.

CONDITIONS.

1. The Cottages may either be single or in villages. The names of intending Competitors must be intimated to the Conveners appointed by the Society, on or before the 20th of June next, but after that day, no new name shall be admitted; in every case, the occupiers of Gentlemen's Lodges, and Gardener's Houses shall be excluded, as well as Gentlemen's Servants occupying Cottages in the policies, or on land in the natural possession of their masters. The inspection of the Cottages and Gardens to take place between 20th June and 12th September. In making the inspection, the Conveners may take the assistance of any competent judge.

2. In order to authorize the awarding of the Premiums, the annual value of the Cottage of the Competitor, with the ground annexed, must not exceed £5 sterling, and there must, at least, be two Competitors in the District. No Cottage or Garden for which a Premium has been awarded by the Society, will be admitted in competition again for the same or a lower Premium. If the Cottage is occupied by the proprietor, the roof must be in good repair; if the roof is of thatch, it must be in good repair, though in the occupation of a tenant. The interior must be clean and orderly,—the windows must be free of broken glass, and perfectly clean, and must afford the means of ventilation. Dunghills, and all other nuisances, must be removed from the front and gables; and the necessary must be kept clean. The peat-stacks, if any, must be so placed as not to be a deformity. In awarding the Cottage Premiums, the preference will be given to those who, in addition to these requisites, have displayed the greatest taste in ornamenting the exterior of their houses, and the ground in front and at the gables. In the event of there being only one Competitor, it will be in the power of the

Committee to award one-half of the Premium, if the merits of the Cottage shall appear to be such as to deserve it.

3. In estimating the claims of Competitors for the Garden Premium, the Judges will have in view—1st, The sufficiency and neatness of the fences; 2d, The cleanness of the ground, and neatness of the walks; 3d, The quality of the crops, and general productiveness of the garden; and, 4th, The choice of crops. Much advantage is derived in some districts of Scotland, from Cottagers cultivating, besides the more common crops, a portion of early potatoes along with the late, of early cabbage, early pease, beet-root, mangel wurzel, Jerusalem artichoke, with some gooseberry and currant bushes, and a fruit-tree trained against the wall, &c.

4. Reports, stating that the various particulars before mentioned have been attended to, the number of Competitors, the names of the successful parties, and the nature of the exertions which have been made by them, must be transmitted by the Conveners to the Secretary of the Society, on or before the 10th day of October next.

5. The Premiums are given for four successive years in each parish. In any parish where the Convener may think it unnecessary to continue them for so long a period, he is requested to state this in his annual Report, and the Directors will be guided by his recommendation. When the Convener shall neglect to make a Report, or to assign a satisfactory reason for there being no Competition, the name of the parish shall in the following year be struck off the list.

6. Similar Premiums will be given, for four successive years, to as many additional parishes, according to priority of application, as will make, with those already on the list, the whole number of the competing parishes thirty-two, on condition that a satisfactory guarantee for one-half of the amount of the Premiums to be given, shall be lodged by each parish with the Secretary, on or before the 1st of January 1848.

2. MEDALS TO COTTAGERS.

In the view of giving still farther encouragement to Cottagers who do not reside in parishes in which the regular Premiums are in operation, the Society will issue annually twelve Cottage Medals to Local Associations and individuals, who, at their own expense, establish Premiums for the like objects.

Application for these Medals, stating the amount of the Premiums given by the parties applying, must be made to the Society on or before the 1st of July in each year. The Medals will afterwards be issued upon a Report, certified in the terms required by the preceding conditions, describing the merits of the Cottages. The Reports to be lodged with the Secretary before the 10th November of the year in which the application is made.

PREMIUMS TO PROPRIETORS.

1. PREMIUMS FOR IMPROVING COTTAGES.

1. To the proprietor in Scotland who shall have improved and enlarged in the most satisfactory manner, during the years 1845, 1846, and 1847, five or more Cottages—The Gold Medal.

2. PREMIUMS FOR BUILDING COTTAGES.

To the Proprietor who shall have erected on his estate, during the years 1845, 1846, 1847, and 1848, the greatest number of approved Cottages—The Gold Medal.

3. ACCOMMODATION FOR FARM SERVANTS.

To the Proprietor in Scotland who shall have erected on his estate, in 1847, 1848, and 1849, the most approved Farm Steading in reference to the proper accommodation of Farm Servants.

Rents of Farms not to exceed £200.

CONDITIONS.

Premium No. 1. being in Competition this year, claims must be lodged with the Secretary on or before the 1st of October next, to allow an inspection to be made of the different cottages. The inspections will be conducted by Committees of the Society's Members in the different Districts; and Reports must be transmitted by the Conveners to the Secretary on or before the 30th November.

The annual value of the cottage or cottages separately, with garden-ground, must not exceed £5.

In estimating the claims of Competitors, the following points will be kept in view,—the external appearance of the cottages, their internal accommodation—the arrangement of the out-houses—the means of drainage and ventilation, and the expense of the building compared with the durability and accommodation. When the cottages of one Competitor are superior in style and comfort to those of another, though not so numerous, the Inspectors to give them the preference, provided they amount at least to five, and have been erected at a moderate expense.

Parties competing, to forward plans, specifications, and estimates to the Society, of which, and of all information sent therewith, copies may be taken for publication, if the Society shall see fit, and the originals returned to the parties within six months, if desired.

4. USE OF THE SPADE.

The Society, with the view of promoting dexterity in the use of the Spade, will give the following Premiums in the parishes aftermentioned, viz.—

Perthshire.

1844—PARISH OF REDGORTON.—Convener, Robert Graham, Esq. of Balgowan.

Argyleshire.

1847—QUOAD SACRA PARISH OF LOCHGILPHEAD.—Convener, Alexander Campbell, Esq. of Auchindarroch.

PREMIUMS.

For the best specimen of Spade Work in each of these Parishes, at a competition between not fewer than twelve Competitors the sum of £1, 5s.

For the second best, 15s.

For the third best, 10s.; And 30s. will be at the disposal of the Convener and Committee, for division among the unsuccessful Competitors.

CONDITIONS.

At least one month before the day of Competition, the time and place of competition, the quantity of ground to be turned over by each Competitor, the depth to which it is to be dug, the manner in which the spits are to be laid, and the time to be allowed for the performance of the work, (which, in all cases, care will be taken shall be ample,) shall be fixed and declared by the Convener; and, where practicable, there shall have been dug, in a central situation, a piece of ground affording a sufficient specimen of the manner in which the work is to be performed, which is to be done by the spade only, and not by the shovel. The Convener shall decide the Premiums, with the assistance of such other Members of the Society as may attend. Failing the attendance of more than one Member, the assistance of competent judges to be taken. In case of perfect equality, the preference to be given to the Lot which is first finished. Gardeners, and persons who have gained first Premiums, to be excluded from competing. The Competitions must take place on or before the 11th of November next, and be reported to the Secretary of the Society on or before the 1st December following. Any parish failing to report within the time specified, shall forfeit the benefit of the Premiums in future years.

The like Premiums will be given in four additional parishes in the year 1848, and three succeeding years, on guarantees to the amount of half of the Premiums offered being lodged with the Secretary by the parties making the application, on or before the 1st of January next.

Note.—These Premiums are proposed chiefly for the benefit of Districts in which there is a redundant population.

In order that the Premiums offered may be made known to industrious Cottagers, the Society trusts much to the obliging co-operation of the Clergy, in the Counties in which the Cottage Premiums are offered.

GENERAL SHOW OF LIVE STOCK,

AND

AGRICULTURAL MEETING AT ABERDEEN IN 1847.

The Society having resolved to hold the General Show of Live

Stock and the Agricultural Meeting for 1847 at ABERDEEN, the following Premiums will be awarded, aided by Donations from the Noblemen, Gentlemen, and Local Agricultural Associations of the Counties more immediately interested, and from the City of Aberdeen.

The Competition is open to Stock from every part of the United Kingdom. The Show will take place on the 4th, 5th, and 6th of August.

The arrangements will be :—

WEDNESDAY, 4th August.—The Exhibition of Agricultural Implements, Dairy Produce, Roots, Seeds, and Plants.

THURSDAY, 5th August.—The Exhibition of Cattle, Horses, Sheep, Swine, Poultry, and the whole of the articles exhibited on Wednesday.

FRIDAY, 6th August.—The Exhibition of the Prize Stock, Implements, and other articles.

CLASS I.—CATTLE.

SHORT-HORNED BREED.

SECTION I. For the best Bull of any age—Twenty-five Sovereigns.

For the second best ditto—Fifteen Sovereigns.

For the third best ditto—The Silver Medal.

To the Breeder of the best Bull in this Section—The Silver Medal.

II. For the best Bull, calved after 1st January 1845—Fifteen Sovereigns.

For the second best ditto—Ten Sovereigns.

III. For the best Bull, calved after 1st January 1846—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

IV. For the best Cow of any age—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

For the third best ditto—The Silver Medal.

V. For the best Pair of Cows—Seven Sovereigns.

VI. For the best Heifer, calved after 1st January 1845—Seven Sovereigns.

For the second best ditto—Four Sovereigns.

For the third best ditto—The Silver Medal.

VII. For the best Pair of Heifers, calved after 1st January 1845—Seven Sovereigns.

VIII. For the best Heifer, calved after 1st January 1846—Five Sovereigns.

For the second best ditto—Three Sovereigns.

IX. For the best Pair of Heifers, calved after 1st January 1846—Five Sovereigns.

ABERDEEN, ANGUS, AND GALLOWAY POLLED BREEDS.

X. For the best Bull of any age—Twenty-five Sovereigns.

For the second best ditto—Fifteen Sovereigns.

For the third best ditto—The Silver Medal.

To the Breeder of the best Bull in this Section—The Silver Medal.

XI. For the best Bull, calved after 1st January 1845—Fifteen Sovereigns.

For the second best ditto—Ten Sovereigns.

XII. For the best Bull, calved after 1st January 1846—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

XIII. For the best Cow of any age—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

For the third best ditto—The Silver Medal.

XIV. For the best Pair of Cows—Seven Sovereigns.

XV. For the best Heifer, calved after 1st January 1845—Seven Sovereigns.

For the second best ditto—Four Sovereigns.

For the third best ditto—The Silver Medal.

XVI. For the best Pair of Heifers, calved after 1st January 1845—Seven Sovereigns.

XVII. For the best Heifer, calved after 1st January 1846—Five Sovereigns.

For the second best ditto—Three Sovereigns.

XVIII. For the best Pair of Heifers, calved after 1st January 1846—Five Sovereigns.

XIX. For the best Ox, calved after 1st January 1844—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

For the third best ditto—The Silver Medal.

XX. For the best Ox, calved after 1st January 1845—Seven Sovereigns.

For the second best ditto—Four Sovereigns.

ABERDEENSHIRE HORNED BREED.

XXI. For the best Bull of any age—Ten Sovereigns.

XXII. For the best Cow of any age—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

XXIII. For the best Heifer, calved after 1st January 1845—Seven Sovereigns.

For the second best ditto—Four Sovereigns.

XXIV. For the best Ox, calved after 1st January 1844—Seven Sovereigns.

For the second best ditto—Four Sovereigns.

XXV. For the best Ox, calved after 1st January 1845—Five Sovereigns.

For the second best ditto—Three Sovereigns.

WEST HIGHLAND BREED.

XXVI. For the best Bull of any age—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

To the Breeder of the best Bull in this Section, the Silver Medal.

XXVII. For the best Cow of any Age—Seven Sovereigns.

For the second best ditto—Four Sovereigns.

XXVIII. For the best Heifer, calved after 1st January 1845—Five Sovereigns.

For the second best ditto—Three Sovereigns.

XXIX. For the best Ox, calved after 1st January 1844—Five Sovereigns.

For the second best ditto—Three Sovereigns.

CROSS BREED.

XXX. For the best Heifer for Fattening, of any Cross, calved after 1st January 1845—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

For the third best ditto—The Silver Medal.

XXXI. For the best Ox of any Cross, calved after 1st January 1844—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

For the third best ditto—The Silver Medal.

XXXII. For the best Ox of any Cross, calved after 1st January 1845—Seven Sovereigns.

For the second best ditto—Four Sovereigns.

For the third best ditto—The Silver Medal.

ANY BREED.

XXXIII. For the best Dairy Cow of any breed—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

XXXIV. For the best Heifer, showing most symmetry, fat, and weight, calved after 1st January 1844—Ten Sovereigns.

XXXV. For the best Ox of any age. The age and breed to be specified—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

CLASS II.—HORSES.

Section I. For the best Entire Horse, for Agricultural purposes, not under four and not exceeding ten years old—Thirty Sovereigns.

For the second best ditto—Twenty Sovereigns.

For the third best ditto—Ten Sovereigns.

The Prize Horses to serve in the three Counties of Aberdeen, Banff, and Kincardine, in season 1848, according to the arrangement which may be fixed by the Committee. The number of Mares to be served by each horse not to exceed seventy. The party claiming the service must guarantee to the owner of the horse a payment of Seventy Sovereigns, or One Sovereign for each Mare, and 2s. 6d. to the Groom for each Mare.

II. For the best Draught (Entire) Colt, foaled after 1st January 1844—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

III. For the best Breeding Mare for Agricultural purposes, having had at least one foal—Ten Sovereigns.

For the second best ditto—Five Sovereigns.

For the third best ditto—The Silver Medal.

IV. For the best Filly for Agricultural purposes, foaled after 1st January 1844—Seven Sovereigns.

For the second best ditto—Four Sovereigns.

For the third best ditto—The Silver Medal.

V. For the best Filly for Agricultural purposes, foaled after 1st January 1845—Five Sovereigns.

For the second best ditto—Three Sovereigns.

VI. For the best Draught Gelding, foaled after 1st January 1843—Seven Sovereigns.

For the second best ditto—Four Sovereigns.

VII. For the best Draught Gelding, foaled after 1st January 1844—Five Sovereigns.

For the second best ditto—Three Sovereigns.

CLASS III. SHEEP.

BLACK-FACED BREED.

SECTION I. For the best Tup, not exceeding forty-five months old —Five Sovereigns.

For the second best ditto—Three Sovereigns.

II. For the best Pen of Five Ewes, not exceeding five years and seven months old, selected from a regular Breeding Stock, not less than one hundred, and the Pen having reared Lambs for the season—Five Sovereigns.

For the second best ditto—Three Sovereigns.

III. For the best Five Gimmers; selected from a Hirsel not less than one hundred, and kept with the others of that age up to 1st June previous to the Show—Five Sovereigns.

IV. For the best Pen of Five Wethers, not exceeding five years and five months old—Five Sovereigns.

CHEVIOT BREED.

V. For the best Tup, not exceeding forty-five months old—Five Sovereigns.

For the second best ditto—Three Sovereigns.

VI. For the best Pen of Five Ewes, not exceeding five years, and which have reared Lambs for the season 1847—Five Sovereigns.

For the second best ditto—Three Sovereigns.

VII. For the best Pen of Five Gimmers—Five Sovereigns.

For the second best ditto—Three Sovereigns.

LEICESTER BREED.

VIII. For the best Tup, not exceeding forty-five months old—Five Sovereigns.

For the second best ditto—Three Sovereigns.

IX. For the best Shearling Tup—Five Sovereigns.

For the second best ditto—Three Sovereigns.

X. For the best Pen of Three Ewes of any age—Five Sovereigns.

For the second best ditto—Three Sovereigns.

SOUTHDOWN BREED.

XI. For the best Tup, not exceeding four years old—Five Sovereigns.

For the second best ditto—Three Sovereigns.

XII. For the best Pen of Three Ewes—Five Sovereigns.

For the second best ditto—Three Sovereigns.

CROSSES.

XIII. For the best Pen of Five Fat Wethers of any Cross or Age (the Cross and Age being specified)—Five Sovereigns.

For the second best ditto—Three Sovereigns.

For the third best ditto—The Silver Medal.

CLASS IV.—SWINE.

Section I. For the best Boar, large Breed—Four Sovereigns.

For the second best ditto—Two Sovereigns.

For the third best ditto, the Silver Medal.

II. For the best Boar, small Breed—Four Sovereigns.

For the second best ditto—Two Sovereigns.

For the third best ditto—The Silver Medal.

III. For the best Sow, large Breed, in Pig or Milk—Four Sovereigns.

For the second best ditto—Two Sovereigns.

For the third best ditto—The Silver Medal.

IV. For the best Sow, small Breed, in Pig or Milk—Four Sovereigns.

For the second best ditto—Two Sovereigns.

For the third best ditto—The Silver Medal.

CLASS V.—POULTRY.

Section I. For the best couple of Turkeys of the Black Breed—Two Sovereigns.

For the second best ditto—The Silver Medal.

II. For the best two Capon Turkeys—Two Sovereigns.

For the second best ditto—The Silver Medal.

III. For the best Couple of Fowls of the Mottled or Speckled Dorking Breed—Two Sovereigns.

For the second best ditto—The Silver Medal.

IV. For the best couple of Fowls of the Polish Breed—Two Sovereigns.

For the second best ditto—The Silver Medal.

V. For the best couple of Fowls of the Spangled Hamburg, or Old Breed of Scotland—Two Sovereigns.

For the second best ditto—The Silver Medal.

VI. For the best couple of Fowls of the Malay Breed—Two Sovereigns.

For the second best ditto—The Silver Medal.

VII. For the best two Capons—Two Sovereigns.

VIII. For the best two Pollards—Two Sovereigns.

IX. For the best couple of Ducks—Two Sovereigns.

For the second best ditto—The Silver Medal.

Attention is directed to the Aylesbury Duck.

X. For the best pair of Geese—Two Sovereigns.

For the second best ditto—The Silver Medal.

NOTE.—The Poultry for the above Premiums must have been bred and reared in Scotland. When the word "Pair" or "Couple" is used, it is understood that a Male and Female of each breed is to be exhibited.

XI. For the best Poultry of any description, without restriction or limitation as to the place where they have been bred or reared—Two Sovereigns.

CLASS VI.—DAIRY PRODUCE.

I. CURING BUTTER.

SECTION I. To the Owner of any Dairy in Scotland, who shall have made and Cured, during the season 1847, the best quality of Butter for the market—the quantity made during the season not being less than 2 cwt.—Five Sovereigns.

For the second best quality—Three Sovereigns.

For the third best quality—The Silver Medal.

The samples exhibited not to be under 14 lbs. in weight, and a declaration to be lodged with the Secretary, stating the quantity made and cured, and that the sample produced is a fair average of the Stock, and farther specifying the ingredients and proportions thereof used in curing.

2. MAKING CHEESE.

SECTION II. To the Owner of any Dairy in Scotland who shall make and produce the best specimen of Sweet or Full Milk Cheese, made in 1847—Five Sovereigns.

For the second best quality—Three Sovereigns.

III. To the Owner of any Dairy in Scotland who shall make and produce the best specimen of Cheese, made in 1847, from Skimmed Milk—Five Sovereigns.

For the second best quality—Three Sovereigns.

The whole quantity of each variety of Cheese exhibited, made by each Competitor during the season, must not be less than 1 cwt., and the quantity produced to consist of not fewer than Two Cheeses in each section, and a declaration must be lodged with the Secretary that the samples exhibited are a fair average of the kind made by the Competitor. The quantity made during the season to be stated.

The Milk for the Skimmed Milk Cheese must have stood at least twenty-four hours before being skimmed.

In the event of two or more competing lots of Butter or Cheese being deemed equal in quality, the Premium will be awarded to the greatest quantity made.

CLASS VII.—IMPLEMENTS, EXTRA STOCK, ROOTS, SEEDS, ETC.

IMPLEMENTS.

Such sum as the Committee may authorize, not exceeding One Hundred Pounds, will be awarded in Premiums for approved Implements and Utensils used for Farm Purposes, or in any rural occupation.

EXTRA STOCK, ROOTS, SEEDS, ETC.

For Extra Stock of any kind not included in the above list of premiums, and not exceeding in one lot five Cattle or Ten Sheep, and for Roots, Seeds, &c., Premiums will be awarded in Medals.

GENERAL REGULATIONS.

1. The Stock must, at the date of the Competition, be *bona fide* the property and in the possession of the party in whose name it is entered, and it must have been so from the 1st of May preceding.

2. The ages of the Stock will be calculated from the 1st of January of the year of birth. When the precise age is known, it is to be stated in the Certificate.

3. Cattle fed on Distillery or Brewer's wash or grains are excluded from Competition, except as Extra Stock. When oil-cake or grain has been used, the quantities are to be stated in the Certificate.

4. Cows in competition must have had a calf in 1847, or be in calf. In the case of a Cow not calved, the Premium will be withheld, till she is certified to have produced a Calf within the year.

5. Evidence may be required that Stallions and Bulls, of four years old and upwards, for which Premiums may be awarded, had produce in the preceding year.

6. Sheep in competition must not have been clipped earlier, or otherwise than the Stock to which they belong. Ewes must have reared Lambs in 1847, and must form parts of regular Breeding Stocks.

7. An animal having already gained a *first* Premium at a General Show of the Society, cannot again compete in a class of the same denomination. If shown as Extra Stock, the Proprietor may receive the Silver Medal.

8. It is desirable that paint should not be used upon the wood or iron-work of the implements or machines exhibited, but they may be coated with transparent varnish. Exhibitors must be prepared, if required by the Judges, to separate the parts of implements or machines, and must come provided with instruments for that purpose.

9. All Stock, and other articles entered, must be exhibited, unless unavoidably prevented. If not brought forward, the Owner will be liable in the expense caused by the Entry.

10. His Grace the Duke of Montrose, President, and the Vice-Presidents of the Society; the Lord-Lieutenants, Vice-Lieutenants, Members of Parliament, and Conveners of the Counties of Aberdeen, Banff, and Kincardine, with an adequate number of the Members of the Society to be named by these Counties on the 30th of April, and by the City of Aberdeen, together with the Secretaries of the local Agricultural Associations, have been appointed a Committee for regulating all details connected with the Meeting. Robert Grant, Esq. of Tillyfour, Convener of the County of Aberdeen, has been nominated Chairman and Convener, and Newell Burnett, Esq., Aberdeen, Secretary of the Committee.

11. No change can be made on the General Regulations, unless submitted and approved of at a Meeting of the Directors in Edinburgh, and duly intimated by Advertisement.

12. The Premiums awarded will be paid with the Society's general premiums, on or after the 10th of February 1848; Premiums not applied for within two years from the term of payment will be forfeited.

ENTRY OF STOCK.

1. The Stock to be exhibited must be intimated by a Certificate for each Lot, according to the forms hereto annexed. The Exhibitor, or person in charge of the Stock may be required to confirm the Certificate, in the presence of a Magistrate, on the day of Competition. Implements must be intimated by a notice or memorandum, specifying the articles, and communicating such particulars as the inventor may deem interesting or important.

2. Printed Certificates to be completed with the required particulars, and to be subscribed by the Exhibitor, may be had at the Society's Hall in Edinburgh, or in Aberdeen at the office of Newell Burnett, Esq., the Local Secretary.

The Secretary will be at the Royal Hotel, Aberdeen, on the 7th, 8th, and 9th of July, to receive Certificates and superintend the arrangements.

3. Certificates of Stock and notices of Implements may be lodged with the Secretary in Edinburgh, or the Local Secretary in Aberdeen, at any time up *to the 9th of July, but after that period no Entry will be allowed.*

4. A Competitor cannot enter more than three Lots in any one Section. The same Lot can be entered in one Section only, and no Lot after entry can be withdrawn for competition in another Section, without the authority of the Committee.

5. Animals, of an age or breed not specified in the sections of the Premium List, may be entered as Extra Stock if duly intimated by Certificate. Dairy produce,

poultry, seeds, roots, plants, &c., must also be intimated by Certificates, lodged as above at Edinburgh, or Aberdeen, on or before the 9th of July.

6. A List of the Exhibitors of Stock and articles entered on or before the 9th of July, will be immediately prepared, and none will be allowed to compete who are not included in that List.

PLACING OF STOCK, ETC., IN SHOW-YARD.

1. No article will be admitted within the Show-Yard without an admission order. These orders will be had, on application, at the office of Mr. Burnett, in Aberdeen, after the 25th of July.

2. One Servant for each Lot only will be admitted, and he must continue in charge of his Lot in the Show-Yard. Bulls must be secured by a ring or screw in the nose, with a chain or rope attached; otherwise they will not be admitted. The Competing Stock will be distinguished by numbers, and the Owner's name must not be mentioned, till the Premiums are decided.

3. Implements and Machines, Seeds, Roots, Plants, and Dairy Produce, must be brought to the Show-Yard between 7 and 9 o'clock on the morning of Wednesday the 4th of August.

4. Cattle and other Stock must be brought to the Show-Yard between five and eight o'clock on the morning of Thursday the 5th. At eight o'clock the Show-Yard will be cleared of all persons except the Judges and their attending Members, in order that the Inspection may proceed, and the public be admitted without delay.

JUDGES.

1. Skilful persons, divided into Sections, will be appointed to act as Judges. The Judges of Implements, Seeds, Roots, and Dairy Produce, will commence at Nine o'clock on the morning of Wednesday the 4th; the Judges of Stock will commence at Eight o'clock on the morning of Thursday the 5th. The Judges will particularly attend to the instructions hereto annexed.

2. A member of the Committee, or of the Deputation of Directors, will be appointed to attend each section of the Judges. As soon as the Judges shall determine which animal or animals are entitled to the Prizes in their respective Sections, the Member of the Committee or Deputation of Directors shall affix Tickets on the animals, that the public may have the earliest opportunity to examine the points of the Prize Cattle. None of the Tickets so placed shall be removed. If any Prize Ticket be removed, and affixed to an animal which has not obtained a Premium, the parties so offending shall be proceeded against as the Committee of Directors may appoint. On Thursday, the Stock shall be withdrawn, and the Show-Yard shut at four o'clock.

EXHIBITION OF PRIZE STOCK.

All the *Prize* Animals, Implements, and other articles, shall be brought to the Show-Ground by ten o'clock in the morning of the day immediately after the General Show, (viz. on Friday,) under penalty of the owner forfeiting the Premiums. The Deputation of the Directors will then determine if Portraits of any of the Prize Animals shall be taken for the Society's Museum, and, in the event of any being selected, the owners may be required to keep them in, or near the town, for such a reasonable time as may be necessary to take the Portrait, under the penalty of forfeiting the Premium. The expense attending the detention, which will be limited to four days, to be paid to the owner by the Society, at a rate not exceeding 7s. 6d. per day. Exhibitors who may have Stock possessing particular merit, especially such animals as have been commended

by the Judges, are invited to show them on this day, for the gratification of practica Breeders, when a favourable opportunity may be given to sell both Breeding and Fat Stock to advantage.

AUCTION.

An Auction will be held within the Show-Yard, on Friday the 6th, under the direction of the Society; the Regulations will be published along with the usual Programme of Business.

INSTRUCTIONS TO THE JUDGES.

1. The Judges will assemble on the morning of the Show, at the time and place to be appointed by the Committee. When it is intimated that the Stock is ready to be examined, the Judges will proceed to the respective Sections which have been assigned to them. Without inquiry as to the names of parties or places, they will decide upon the merits of the animals, and their awards shall make reference merely to the *numbers* which distinguish the animals. The Member of the Committee or Deputation of Directors, who attends each section of the Judges, will receive from the Secretary blank reports, to be completed by him, under their instructions, with the awards of the Premiums. In these Reports, the *numbers* referable to the lots recommended must be distinctly inserted. The Judges will report not only those animals entitled to Premiums, but also the next in merit in each Section, to meet the contingency of any challenge which may be made against the Prize animals. They will also point out any animals, portraits of which they may consider should be taken for the Society's Museum. They will sign and deliver their Report, and they are not afterwards to propose any change. In the event of a difference of opinion, that of the majority of the Judges who have examined the Lot shall be conclusive. When the Report is delivered to the Committee, the duty of the Judges shall cease, and the Committee shall award the Premiums.

2. The Judges, in examining the Stock, will proceed on the understanding that the Committee are satisfied with the regularity of the Certificates; but if any of the Stock does not, in their opinion, come within the Regulations, or is of such a character as ought not to be exhibited, they will state their opinion to the Committee, that such course may be adopted as shall appear necessary. Should the Judges desire to have the information communicated in the Certificates, as to the mode of feeding or other particulars, they will apply for the same to the Committee through the Secretary.

3. The Judges will have regard to the symmetry, early maturity, purity, size, and general qualities characteristic of the breeds of which they judge. They will make due allowance for age, feeding, distance travelled, and other circumstances, bearing on the character and condition of the animals. They will not give encouragement for over-fed animals. They will not award Premiums for Bulls, Cows, or Heifers, which shall appear to have been fattened for the butcher, the object being to have superior animals of these descriptions for breeding. In no case shall a Premium be adjudged, unless the Judges shall deem the animals to have sufficient merit, more especially if only one lot is presented for any of the Premiums.

FORM OF CERTIFICATE FOR FAT OXEN.

I, , near the post town of , in the county of , do certify, That my Ox (or Oxen, as the case may be) of the breed, to be shown at the General Show of Live Stock at Aberdeen, for the Premium in Section was bred by Mr. of , and purchased by me from on or about ; he was calved , and will, at the date of the Show, be . years and months old, and has been fed by me on . The

quantity of cake or corn he has consumed has been . He has not at any time been fed on distillery or brewers' wash or grains. He will have to travel on foot (or by steam, or other conveyance, as the case may be) miles, or thereby, from the place of feeding to the Show at Aberdeen. He was first put up to fatten on or about the day of . Witness my hand this day of 1847.

(*Signature of the Exhibitor.*)

N.B. Any observations as to the animal's appearance and state of flesh when put up to feed, or other particulars which the Exhibitor may think material, and more especially the pedigree, may be subjoined to the above certificate.

FORM OF CERTIFICATE FOR CATTLE—LEAN OR BREEDING STOCK.

I, of , near , in the county of , do certify, That my of the breed, to be shown at the General Show of Live Stock at Aberdeen, for the Premium in Section bred by , and purchased by me from , on or about , and calved , will, at the date of the Show, be years and months old, and since being in my possession, has been fed on ; will have to travel on foot miles or thereby, to the Show at Aberdeen. Witness my hand this day of 1847.

(*Signature of the Exhibitor.*)

N.B.—Any observations with reference to other particulars, which the Exhibitor may think material, may be subjoined to the above certificate. The pedigree, when known, must also be stated.

FORM OF CERTIFICATE FOR HORSES, SHEEP, OR SWINE.

I, of , near , in the county of , do certify, That my of the breed, to be shown at the General Show of Live Stock at Aberdeen, for the Premium in Section , bred by , and purchased by me from , on or about , foaled (lambed or pigged, as the case may be) , will, at the date of the Show, be years and months old, and since being in my possession, has been fed on ; will have to travel on foot miles or thereby, to the Show at Aberdeen. Witness my hand this day of 1847.

(*Signature of the Exhibitor.*)

N.B.—Any observations with reference to other particulars, which the Exhibitor may think material, may be subjoined to the above certificate. The pedigree, when known, must also be stated.

THE VETERINARY COLLEGE.

This Establishment is conducted under the superintendence of Professor Dick, Veterinary Surgeon, the Lecturer appointed by the Society. The curriculum of study consists in a course of Lectures on the principles and practice of Medicine and Surgery applied to domesticated animals, by Professor Dick; Anatomy and Demonstrations, by Mr. Barlow, V.S.; Pharmacy, by Mr. Worthington,

V.S.; and Chemistry and Materia Medica, by Dr. Wilson, F.R.S.E.

Students enjoy the benefit of assisting in an extensive practice, and ample opportunities are afforded them of performing the different operations which most frequently occur.

Attendance at Two Courses is required before a Student is taken upon trial for diploma; and the Graduates of the College are eligible for appointments in the Army and East India Company's Service as Veterinary Surgeons.

The Professors of Agriculture and Anatomy in the University of Edinburgh give gratuitous admission to their classes to practical Students of the Veterinary College.

The Lectures and Demonstrations for the Session 1847–48 commence at the Institution in November next, of the particulars of which subsequent advertisements will be given.

MUSEUM.

The Museum, George IV. Bridge, is open from eleven till three o'clock, every day except Monday. The public are admitted on inscribing their names in the Visiter's Book. Persons desirous of preserving Models of Agricultural Implements or Machines, or Vegetable or Mineral Specimens, are invited to transmit them to the Conservator of the Museum, by whom they will be included in the Collections, if approved of by the Directors.

MONTHLY MEETINGS.

Meetings are held in the Museum on the first Wednesday of December, February, March, April, May, and June, when Papers are read, and subjects in the science and practice of Agriculture are discussed. The Silver Medal will be awarded to the Authors of such Essays or Papers as may be communicated, and selected by the Directors to be read. Strangers are admitted to the Meetings on application to the Secretary, but only Members can take part in the business.

By order of the Directors,

J[N]. HALL MAXWELL, *Secretary*.

Society's Hall, Albyn Place,
Edinburgh, *10th February* 1847.

LIST OF MEMBERS

OF

THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND,

AT 20TH FEBRUARY, 1847.

ALPHABETICALLY ARRANGED, AND DISTINGUISHING THE YEAR OF ADMISSION.

PRESIDENT,

HIS GRACE JAMES DUKE OF MONTROSE.

The Members marked *, have been Presidents; and † Vice-Presidents.

New Members are admitted at the General Meetings of the Society by Ballot. There are two such Meetings Annually, viz. the Anniversary Meeting, on the second Tuesday of January, and the Summer General Meeting, on such day in June or July as may be fixed by the Directors, and intimated in terms of the Charter. Members pay either an Annual Contribution of £1, 3s. 6d.; or a Life Subscription of Twelve Guineas.

EDINBURGH:
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PRINTER TO HER MAJESTY.

MDCCCXLVII.

G

LIST OF MEMBERS.

	Admitted
Argyll, His Grace John Douglas Edward Henry, Duke of	1798
Atholl, His Grace George Augustus Frederick John, Duke of	1834
Atholl, Her Grace Ann, Duchess of	1841
Ailsa, The Most Noble Archibald, Marquis of	1847
Abercorn, The Most Noble James, Marquis of, K.G.	1833
†Airlie, The Right Hon. David, Earl of	1819
†Aberdeen, The Right Hon. George, Earl of, K.T.	1805
Aboyne, The Right Hon. Charles, Eail of	1819
†Arbuthnott, The Right Hon. John, Viscount	1803
Aberdour, The Right Hon. Sholto John, Lord	1846
Abercromby, The Right Hon. George Ralph, Lord	1825
Abinger, The Right Hon. R. C., Lord	1841
Arbuthnott, Lieut.-General the Hon. Hugh, M.P. for Kincardineshire	1811
Arbuthnott, The Hon. John	1833
Abercromby, Sir Robert, of Birkenbog and Forglen, Bart.	1816
Abercromby, Lady, of Birkenbog and Netherlaw	1840
Agnew, Sir Andrew, of Lochnaw, Bart.	1829
Antrobus, Sir Edmund, of Rutherford, Bart.	1829
Anstruther, Sir Windham Carmichael of Anstruther and Carmichael, Bart.	1842
Anstruther, Sir Ralph Abercrombie, of Balcaskie and Watten, Bart.	1832
Adam, Vice-Admiral Sir Charles, of Blair-Adam, K.C.B.	1829
Alexander, Sir James Edward	1831
Angrand, The Chevalier, late Consul of France at Edinburgh	1839
Abercromby, Alexander, Glasgow	1844
Abercromby, Arthur, of Glassaugh	1832
Adair, John, of Genoch	1829
Adam, James, W.S.	1807
Adam, James, Denovan Field	1839
Adam, James, S.S.C.	1842
Adam, John, of Scobbach, Turriff	1839
Adam, William, of Ranna, Advocate, Aberdeen	1839
Addie, Robert, of Whiterig	1844
Adinston, Thomas, of Carcant	1842

	Admitted
Agnew, Robert Vans, of Sheuchan and Barnbarroch	1843
Ainslie, John, of Maxpofle	1831
Ainslie, P. B., St. Colme House	1826
Ainslie, Robert, W.S.	1847
Aitchison, Francis, of Borland	1831
Aitchison, James, of Alderston	1822
Aitchison, William, at Linhope	1835
Aitken, Robert, Glasgow	1844
Aitken, James, Gartcous	1834
Aiton, Rev. Dr. John, Minister of Dolphinton	1828
Alcock, Robert, late Advocate, Aberdeen	1833
Alexander, Alexander Humphreys	1825
Alexander, Boyd, of Southbar	1823
Alexander, James, of Balmule	1842
Alexander, W. Maxwell, of Ballochmyle	1823
Alison, Alexander, Glasgow	1814
Alison, Archibald, Advocate, Sheriff of Lanarkshire	1838
Alison, Robert, Dundee	1843
Allan, Alexander, Advocate	1833
Allan, John, Old Liston, Kirkliston	1840
Allan, William, of Glen and Hillside	1830
Allan, Lieut.-Colonel, Glen	1847
Allardice, Robert Barclay, of Ury	1810
Allen, James, Merchant, Grangemouth	1815
Allen, John Lee, of Erroll	1821
Allen, John James, younger of Erroll, Captain R.N.	1839
Alston, George, of Muirburn	1838
Alston, James W., of Stockbriggs	1844
Alston, John, Manufacturer, Glasgow	1827
Anderson, Adam, LL.D, St. Andrews	1829
Anderson, Adam, Advocate	1834
Anderson, Alexander, Advocate, Aberdeen	1838
Anderson, A. D., M.D., Glasgow	1844
Anderson, Major Alexander, of Montrave, H.E.I.C.S.	1833
Anderson, David, of Moredun	1825
Anderson, David, of St. Germains	1829
Anderson, David, Westhaven, Dundee	1843
Anderson, Francis, W.S.	1841
Anderson, George, Solicitor, Inverness	1839
Anderson, George, Glasgow	1844
Anderson, James, Newton of Ballunie	1838
Anderson, James A., Banker, Glasgow	1838
Anderson, James, of Gorthleck	1839
Anderson, James, Glasgow	1843
Anderson, John, Merchant, London	1838
Anderson, John, Merchant, Glasgow	1838

	Admitted
Anderson, John, Factor for Lord Lovat, Strichen	1840
Anderson, Michael, Edinburgh	1831
Anderson, Robert, of Candacraig	1842
Anderson, Robert, Halls, Dunbar	1842
Anderson, Thomas, of Caigance, Advocate	1832
Anderson, William, Town-Clerk of Leith	1842
Anderson, William James, of Techmuiry	1840
Angus, Ritchie, Glasgow	1844
Anstruther, James, Moray Place, Edinburgh	1827
Anstruther, Philip, of Tillicoultry	1846
Arbuthnot, George Clerk, of Mavisbank	1844
Arbuthnot, James Carnegie, of Balnamoon	1813
Arbuthnot, Thomas, of Meethill	1829
Archer, Andrew, Balbrogie, Coupar Angus	1846
Armstrong, Charles, of Cherry Valley, County of Antrim, Ireland	1836
Arkley, Patrick, of Duninald, Advocate	1840
Arnott, G. A. Walker, of Arlary	1837
Arnott, James, of Leithfield, W.S.	1835
Arundell, G. Hunter, of Barjarg	1839
Ashby, Shukbrugh, Edinburgh	1843
Askew, Henry William, of Minard	1845
Aytoun, Roger, of Inchdairnie	1844
Aytoun, Roger,	1826
Aytoun, William Edmonstoune, Advocate	1838

B

BUCKINGHAM and CHANDOS, His Grace Richard Plantagenet, Duke of, K.G., Honorary Member	1837
*BUCCLEUCH and QUEENSBERRY, His Grace Walter Francis, Duke of, K.G.	1828
BUCCLEUCH and QUEENSBERRY, Her Grace, Charlotte, Duchess of	1835
†BUTE, The Most Noble John, Marquis of, K.T.	1815
†BREADALBANE, The Most Noble John, Marquis of	1819
BREADALBANE, The Most Noble Elizabeth, Marchioness of	1838
BUCHAN, The Right Hon. Henry David, Earl of	1811
BALCARRAS, The Right Hon. Earl of	1847
BLANTYRE, Right Hon. Charles, Lord	1843
BELHAVEN and STENTON, The Right Hon. Robert, Lord	1816
BERRIEDALE, The Right Hon. James, Lord	1845
BEXLEY, The Right Hon. Nicholas, Lord, Hon. Mem.	1801
BOYLE, Right Hon. David, of Shewalton, Lord Justice-General	1804
BLACK, The Right Hon. Adam, Lord Provost of the City of Edinburgh	1846

	Admitted
Burnet, Sir Thomas, of Leys, Bart.	1824
Bruce, Sir Michael, of Scotstown and Stenhouse, Bart.	1825
Baird, Sir James Gardner of Saughtonhall, Bart.	1843
Blair, Sir David Hunter, of Blairquhan, Bart.	1801
Baird, Lady Preston, of Ferntower	1809
Baird, Sir David, of Newbyth, Bart.	1838
Baillie, Sir William, of Polkemmet, Bart.	1818
Bannerman, Sir Charles, of Crimmonmogate, Bart.	1834
Bethune, Sir Henry, of Kilconquhar, Bart.	1839
Boswell, Sir James, of Auchinleck, Bart.	1834
Brisbane, General, Sir Thomas M., of Brisbane and Makerston, Bart., G.C.B.	1801
Brown, Sir Samuel, of Netherbyres, Capt. R.N.	1829
Ballingall, Sir George, M.D., Prof. of Military Surgery in the University of Edinburgh	1821
Barns, Lieut.-Gen. Sir James Stevenson of Kirkhill, K.C.B.	1803
Babington, John, Summerville, Dumfries	1846
Baikie, James, of Tankerness	1818
Baillie, Charles, Advocate	1831
Baillie, James Evan, of Glenelg and Kingussie	1839
Baillie, Evan, of Dochfour	1824
Baillie, A. D. Cochrane Wishart, of Lamington	1842
Baillie, George, of Jerviswood	1841
Baillie, Henry James, younger of Redcastle, M.P.	1839
Baillie, Colonel Hugh Duncan, of Redcastle, M.P.	1839
Baillie, John Frederick, of Leys	1839
Baillie, Robert Granberry, of Coulterallers	1819
Baillie, William, yr. of Polkemmet, M.P.	1847
Bain, John, of Morriston	1838
Bain, John, Banker, St. Andrews	1842
Baird, Alexander, of Faskine and Palace Craig	1845
Baird, Charles J., Shotts Iron-works	1844
Baird, Douglas, Gartsherrie	1838
Baird, George, Gartsherrie	1838
Baird, James, Gartsherrie	1838
Baird, John, of Shotts Iron-works	1815
Baird, John, Highcross	1838
Baird, Robert, Gartsherrie	1838
Baird, William, of Gartsherrie	1844
Baird, William, Grain Merchant, Glasgow	1844
Bald, Robert, Civil-Engineer, Edinburgh	1828
Balfour, Charles, of Balgonie	1846
Balfour, David, of Trenabie	1843
Balfour, Francis, of Fernie	1824
Balfour, James, of Whittingham, M.P.	1846
Balfour, James, of Pilrig, W.S.	1824

	Admitted
Balfour, James, Pilmuir, Leven	1842
Balfour, John, of Balbirnie	1839
Balfour, Dr. John Hutton, Professor of Botany in the University of Edinburgh	1839
Balfour, William, of Hiscome	1844
Balfour, William, Merchant, Glasgow	1820
Ballendene, James, of Pitgober	1834
Ballantyne, James, of Castlehill	1822
Ballantyne, James, of Holylee	1832
Bannerman, Alexander, M.P. for the City of Aberdeen	1835
Bannerman, Patrick, Advocate, Aberdeen	1825
Barbour, Thomas, of Dalshangan	1846
Barclay, George Robertson, of Keavil	1834
Barker, Thomas, of Sydney, Australia	1839
Barlas, Robert, Gilmore Place, Edinburgh	1844
Barstow, Charles M., India Street, Edinburgh	1846
Bartholomew, John, Merchant, Glasgow	1838
Bartholomew, Robert, Merchant, Glasgow	1838
Bartholomew, Thomas, Merchant, Glasgow	1838
Bartlemore, Alexander, of Seaside	1825
Bauchope, Robert, Factor for his Grace the Duke of Hamilton, at Kinneil	1831
Baxter, David, Dundee	1843
Baxter, John G., Ellengowan, Dundee	1843
Baxter, William G., Ellengowan, Dundee	1843
Bayley, Isaac, Regent Terrace, Edinburgh	1828
Bayne, Dr. James, Physician, Inverness	1813
Beatson, H. Dundas, Captain, Swift Revenue Cutter	1809
Begbie, Alexander, Leamington	1832
Beith, John, Banker, Campbeltown	1836
Belches, Alexander Hepburn Murray, of Invermay	1824
Belches, Lieut.-Colonel John H. Murray, Invermay	1825
Belford, Andrew, of Glenfintaig, Solicitor, Inverness	1839
Bell, Allan, of Hillowton, Castle-Douglas	1839
Bell, Archibald, Advocate, Sheriff of Ayrshire	1833
Bell, Carlyle, W.S., one of the Principal Clerks of the City of Edinburgh	1824
Bell, George Graham, of Castle O'er, Advocate	1835
Bell, George, Merchant, Leith	1826
Bell, George, of Menslaws	1842
Bell, John, of Enterkine	1839
Bell, John Beatson, of Glenfarg, W.S.	1841
Bell, Robert, Advocate, Sheriff of Berwickshire	1823
Bell, Robert, M.D., Dundee	1843
Bell, Robert, Sheriff-Substitute of Shetland	1846
Bell, William, W.S.	1813

	Admitted
Bell, William, of Gribtac	1840
Berry, William, of Tayfield	1800
Bertram, John Primrose, W.S.	1845
Bertram, Thomas Hardy, Engineer, Reading, Berks	1845
Berwick, Alexander, of Nortonhall	1839
Bethune, John Elliot Drinkwater, of Balfour	1841
Beveridge, Thomas, Depute-Clerk of Session	1816
Beveridge, Thomas Knox, W.S.	1833
Bigg, Thomas, 15, Crawford Street, London	1842
Biscoe, Thomas Porter Bonell, Kingellie, Inverness	1846
Bishop, James, Restonhill	1839
Black, Andrew, Smeaton, Dalkeith	1846
Black, James, Merchant, 17, Blythswood Square, Glasgow	1839
Black, James, Merchant, 12, Montague Place, Glasgow	1839
Black, James, Merchant, Royal Bank Place, Glasgow	1838
Black, James Spens, Merchant, 17, Blythswood Square, Glasgow	1839
Black, Robert, 3, Royal Crescent, Glasgow	1844
Black, William, St. Mary's Buildings, Glasgow	1844
Blackburn, Peter, of Killearn	1842
Blackburn, Robert B., Advocate	1846
Blackwood, John, Publisher, Edinburgh	1842
Blackwood, Robert, Publisher, Edinburgh	1835
Blaikie, Thomas, Lord Provost of Aberdeen	1840
Blaikie, John, of Craigiebuckler, Advocate, Aberdeen	1837
Blair, David Anderson, Advocate	1819
Blair, Major-General Thomas Hunter, C.B., of Dunskey	1835
Blair, Captain William Fordyce, of Blair, R.N.	1844
Blair, William, of Avonton	1817
Blanchard, George, Merchant, Edinburgh	1847
Blandow, Michel Von, St. Petersburgh, Honorary Member	1836
Blane, Robert, of Grougar, 2d Life Guards	1836
Blood, Bindon, of Cranaker, Ireland	1833
Bogle, James, Merchant, Glasgow	1844
Booth, James Godfrey, Seed Merchant, Hamburgh	1842
Bonar, Andrew, Banker, Edinburgh	1824
Bonar, James, late of Kimmerghame	1835
Bonar, William, late Banker, Edinburgh	1828
Bonar, William Graham, of Greigston	1835
Boag, James, Merchant, Edinburgh	1842
Boog, William, Sweethope, Kelso	1841
Borthwick, John, of Crookston	1846
Borthwick, Thomas Chalmers, of Hopesrig	1838
Borthwick, Lieut-Colonel William, Madras Establishment	1843
Boswell, John Irvine, of Kingcaussie and Balmutto	1823
Boswell, John Douglas, of Garallan	1836

	Admitted
Boulderson, Shadwell M., Erchless Castle	1840
Bowie, John, W.S.	1815
Boyd, Adam Black, of Cherrytrees	1841
Boyd, John, of Broadmeadows	1804
Boyle, Archibald Thomas, Advocate	1846
Boyle, Patrick, younger of Shewalton	1835
Brand, William, Secretary Union Bank of Scotland	1846
Brander, Lieut-Colonel James, of Pitgaveny	1827
Brander, James, Banker, Golspie	1830
Brebner, James, Advocate, Aberdeen	1834
Bremner, Charles, W.S.	1800
Bremner, James, Civil-Engineer, Pulteneytown	1839
Briggs, Lieut.-Col. John Falconer, of Strathairly	1828
Brisbane, Thomas Makdougall, yr. of Brisbane	1847
Brock, Henry, Banker, Glasgow	1838
Brodie, James Campbell, of Lethen	1831
Brodie, John, Scoughall	1822
Brodie, John, Abbey Mains	1840
Brodie, John Clerk, W.S.	1840
Brodie, Peter, Clairilaw	1834
Brodie, William, of Brodie	1821
Broom, Alexander, Architect and Builder, Glasgow	1838
Brown, Alexander, Merchant, Aberdeen	1825
Brown, Alexander, Secretary Morayshire Farmers' Club	1832
Brown, Alexander, Merchant, Glasgow	1838
Brown, Alexander, 6, Rutland Square, Edinburgh	1844
Brown, Andrew, of Auchintorlie	1844
Brown, Andrew, Dundee	1844
Brown, Major David, of Park	1834
Brown, David Wardlaw, Blanerne House, Berwickshire	1841
Brown, George, Wattin Mains	1839
Brown, Hugh, of Broadstone, Ayrshire	1823
Brown, Hugh H., of Newhall	1843
Brown, Major J. D., Drylawhill	1821
Brown, James, Accountant, Edinburgh	1816
Brown, James, Dundee	1843
Brown, James, Eskmill	1845
Brown, James, Pentland Mains	1846
Brown, J. S., George Square, Edinburgh	1841
Brown, James Thomas, younger of Auchlochan	1837
Brown, Matthew, Port-Glasgow	1832
Brown, Peter, Linkwood	1821
Brown, Robert, of Drumbrexhill	1802
Brown, Robert, yr. of Gilston	1845
Brown, Thomas, of Lanfine and Waterhaughs	1832
Brown, William, Merchant, Glasgow	1828

	Admitted
Brown, William, Banker, Maybole	1835
Brown, William, Merchant, Dundee	1843
Brown, William Henry, of Ashely	1833
Brown, William, Writer, Dumfries	1846
Bruce, C. L. Cumming, of Roseisle and Kinnaird, M.P.	1817
Bruce, James, Middleton, Mintlaw	1837
Bruce, John, younger of Sumburgh	1829
Bruce, John, W.S., Edinburgh	1842
Bruce, Onesiphorous Tyndall, of Falkland	1829
Bruce, Robert, of Kennet	1819
Bruce, Robert, Advocate, Sheriff of Argyllshire	1828
Bruce, Thomas, of Arnot	1820
Bruce, Thomas, of Langlee, W.S.	1828
Bruce, William, of Bigton, Zetland	1838
Bruce, William, Glasgow	1844
Bryce, David, Architect, Edinburgh	1846
Bryce, Rev. James, D.D., Edinburgh	1813
Buchan, George, of Kelloe	1826
Buchan, William, Farmer and Distiller, Ratho Hall	1839
Buchanan, Alexander, West Whitehill, Garnkirk	1843
Buchanan, Andrew, of Auchintorlie	1838
Buchanan, Andrew, of Mount Vernon	1827
Buchanan, Charles Snodgrass, of Knockshinnoch	1838
Buchanan, George, of Arden	1838
Buchanan, George, of Dowanhill, Merchant, Glasgow	1838
Buchanan, James, Darnaway Street, Edinburgh	1820
Buchanan, James, of Catrine, Ayrshire	1838
Buchanan, John, Coachbuilder, Glasgow	1838
Buchanan, John, junior, Merchant, Glasgow	1838
Buchanan, John, at Finnich	1831
Buchanan, John, of Glenlora	1844
Buchanan, John, of Carbeth	1838
Buchanan, Robert, Glasgow	1811
Buchanan, Rev. Thomas, Minister, Methven	1840
Buchanan, Walter, of Shandon	1842
Buchanan, Walter W., M.D., Greenock	1844
Buchanan, William, Merchant, Glasgow	1828
Buist, James, Kirkton Barnas	1842
Burn, Henry J., W.S., of Cuttlehill	1843
Burn, James, W.S.	1825
Burn, William, Architect	1824
Burnett, Alexander, Crathes	1834
Burnett, Alexander, Tacksman of Kinchyle, Factor for Lady Saltoun	1839
Burnett, Gregory, Ardross	1840
Burnett James Horn W.S.	1834

	Admitted
Burnett, John, of Kemnay	1809
Burnett, John, Writer, Glasgow	1844
Burnett, John Joseph, of Gadgirth	1836
Burnett, Newell, Advocate, Aberdeen	1834
Burnett, Thomas, Advocate, Aberdeen	1825
Burnley, W. F., Merchant, Glasgow	1838
Burns, Thomas Charles, of Avondale	1845
Burt, Dr. John, Edinburgh	1831
Butter, Archibald, of Faskally	1825
Buttery, A. W., Monkland Iron Works	1844
Byres, Andrew, Highstoneridge, Dumfriesshire	1846
Byres, Major-General Patrick, of Tonley	1843

C

Cambridge, His Royal Highness Prince Adolphus Frederick, Duke of, K.G.	1838
Caithness, The Right Hon. Alexander, Earl of	1814
†Cathcart, Lieut.-Gen. Right Hon. Charles, Earl, K.C.B.	1809
†Cawdor, The Right Hon. John Frederick, Earl of	1831
Campbell, The Right Hon. John, Lord	1834
Clerk, The Right Hon. Sir George, of Pennicuik, Bart. M.P.	1812
Cuningham, The Hon. Lord	1833
Cathcart, Colonel, The Hon. Fredrick Macadam, of Craigengillan	1830
Colquhoun, Sir James, of Luss, Bart.	1829
Campbell, Sir John, of Ardnamurchan, Bart.	1829
Campbell, Sir James, of Aberuchill and Kilbride, Bart.	1838
Carmichael, Sir Thomas Gibson, of Castlecraig, Bart.	1806
Carnegie, Sir James, of Southesk, Bart.	1843
Campbell, Sir Hugh Purvis Hume, of Marchmont, Bart. M.P.	1834
Cunningham, Sir Robert Keith Dick, of Prestonfield, Bart.	1816
Cathcart, Sir John Andrew, of Carleton, Bart.	1834
Cumming, Sir William G. Gordon, of Altyre and Gordonston, Bart.	1808
Campbell, Sir Archibald Islay, of Succoth, Bart.	1844
Colebrooke, Sir Thomas Edward, of Crawford, Bart., M.P.	1838
Cameron, Sir Duncan, of Fassfern, Bart.	1800
Campbell, Sir Donald, of Dunstaffnage, Bart.	1823
Campbell, Lieut.-Colonel Sir John, Bart., 38th Regiment	1844
Campbell, Sir Alexander, of Barcaldine, Bart.	1845
Campbell, Lieut.-General Sir Colin, K.C.B.	1816
Campbell, Sir James, Glasgow	1838
Cochrane, Rear-Admiral Sir Thomas, C.B.	1817
Chalmers, Colonel Sir William, of Glenericht	1822
Cadell, Alexander Tod, Madras Army	1844

	Admitted
Cadell, Lieut.-Colonel George, H.E.I.C.S.	1842
Cadell, Hugh Francis, of Cockenzie	1844
Calder, Marcus, Factor for Mr. Balfour of Trenaby	1846
Calder, Robert, Sibster, Caithness	1839
Caldwell, Frederick, of Missinish	1841
Callander, William Burn, of Prestonhall	1818
Callander, Henry, Accountant, Edinburgh	1843
Callander, James Henry, of Craigforth	1830
Cameron, Alexander, Surinam	1819
Cameron, Allan, Calligarry	1803
Cameron, Donald, of Lochiel	1834
Cameron, Donald Charles, of Barcaldine	1825
Cameron, Hugh Innes, Provost of Dingwall	1835
Cameron, Colonel Hugh John, of Letterfinlay	1840
Cameron, James, Ardintrive, Oban	1844
Cameron, John, Corrychoiley	1826
Cameron, John, of Glenesk	1846
Campbell, Lieutenant-Colonel Alexander, of Possil	1810
Campbell, Alexander, of Auchindarroch	1837
Campbell, Captain Alexander, of Brackley	1806
Campbell, Alexander, London	1804
Campbell, Alexander, of Monzie	1833
Campbell, Alexander, of Bedlay	1833
Campbell, Alexander, of Barnhill	1833
Campbell, Alexander, Great Stuart Street, Edinburgh	1835
Campbell, Archibald, younger of Jura	1834
Campbell, Archibald, of Catrinebank	1810
Campbell, Archibald James, of Kilpatrick	1824
Campbell, Archibald, of Glendaruel	1826
Campbell, Archibald, Camusearnie Cottage, Factor on the estate of Menzies	1832
Campbell, Archibald, of Blythswood	1840
Campbell, Archibald, M.D. younger of Lerags	1845
Campbell, Arthur, of Condorrat, W.S.	1816
Campbell, Charles, of Combie	1808
Campbell, Charles, Banker, Glasgow	1838
Campbell, Charles William, of Borland, Killin	1810
Campbell, Colin, of Jura	1810
Campbell, Colin, of Colgrain	1829
Campbell, Colin, younger of Colgrain	1847
Campbell, Colin G., younger of Stonefield	1838
Campbell, Captain Donald, of Barbreck	1840
Campbell, Donald, younger of Sonachan	1840
Campbell, Donald, Breachacha, Factor to M'Lean of Coll	1846
Campbell, Colonel Dugald, Royal Artillery	1818

	Admitted
Campbell, Duncan, of Ross, Advocate	1823
Campbell, Farquhar, Ormsary	1839
Campbell, Francis Garden, of Troupe and Glenlyon	1840
Campbell, George, Succoth	1833
Campbell, George James, of Treesbanks	1835
Campbell, Henry Fletcher, of Boquhan	1823
Campbell, Humphrey Walter, Dunbarton	1838
Campbell, James Archibald, of Inverawe	1833
Campbell, James, of Craigie	1824
Campbell, James, Merchant, Glasgow	1838
Campbell, James, Wine-Merchant, Edinburgh	1839
Campbell, James, younger of Tillichewan	1847
Campbell, James, of Walton Park	1846
Campbell, John, late of Craignure	1803
Campbell, John, of Stonefield	1808
Campbell, John, of Glen Saddel	1817
Campbell, John, of Blairhall	1819
Campbell, John F., younger of Islay	1844
Campbell, John, of Southhall	1821
Campbell, John, of Otter	1827
Campbell, John, of Strachur	1829
Campbell, John, of Achalader	1846
Campbell, John, of Kilberry	1842
Campbell, Colonel John, of Blackhall	1803
Campbell, John Deans, of Curreath and Loeg	1835
Campbell, John Archibald, W.S.	1813
Campbell, John, W.S.	1793
Campbell, Kenneth, of Ardow	1843
Campbell, Lorne, Roseneath	1824
Campbell, Lachlan M'Neill, of Kintarbert	1833
Campbell, Mungo Nutter, of Ballymore	1832
Campbell, Mungo, Jun. Glasgow	1824
Campbell, Mungo, Glasgow	1837
Campbell, Ord Graham, Edinburgh	1838
Campbell, Richard, of Auchinbreck	1833
Campbell, Richard D., Jura	1836
Campbell, Robert, Roseneath	1803
Campbell, Robert, of Sonachan	1802
Campbell, Robert, of Auchmannoch	1816
Campbell, Major Robert Nutter, of Ormidale	1844
Campbell, Rose,	1809
Campbell, Thomas, Cassilis House	1837
Campbell, Walter Frederick, of Islay	1817
Campbell, Major Walter, late of Skipness	1836
Campbell, William, W.S.	1805
Campbell, William, of Tillichewan Castle	1838

	Admitted
Campbell, William, of Ormsary	1839
Campbell, William, of Ederline	1843
Campbell, William B. Stewart, of Clochfoldich, W.S.	1839
Campbell, William L., of Glenfalloch	1833
Cannon, James, Shiel	1813
Carfrae, Major-General John, of Bowerhouse	1842
Carlisle, William, of Houstonfield	1835
Carlyle, Thomas Johnstone, of Waterbeck	1845
Carmichael, James, Raploch Farm	1838
Carmichael, Michael Thomson, of Eastend	1825
Carnaby, Thomas, Clerk of Lieutenancy, Forfarshire	1831
Carnegie, David, Atholl Crescent, Edinburgh	1847
Carnegie, John, of Redhall	1836
Carnegie, William Fullerton Lindsay, of Boysack and Kinblethmont	1824
Carruthers, Alexander, of Warmanbie	1826
Carruthers, William Thomas, of Dormont	1823
Carstairs, Drysdale, Merchant, Leith	1838
Carstairs, John, of Springfield	1841
Cassels, David, late Distiller at Arnprior	1824
Cathcart, Elias, of Blairston	1819
Cathcart, Taylor, of Carbiston and Pitcairly	1842
Cay, John, Advocate, Sheriff of Linlithgowshire	1841
Chalmers, Charles, of Monkshill	1824
Chalmers, David, of Westburn	1834
Chalmers, Patrick, of Auldbar	1834
Chalmers, James, Glenbirnam	1839
Chalmers, John, Ballumbie House, Dundee	1844
Chalmers, Lewis, Fraserburgh, Factor for Lord Saltoun	1833
Chambers, Robert, Edinburgh	1841
Chapman, David, Merchant, Glasgow	1845
Charge, Thomas, of Bartom	1833
Cheape, George, of Wellfield	1834
Cheape, Captain John, of Girgenti	1814
Cheyne, Captain Alexander, Royal Engineers	1825
Cheyne, Henry, of Tangwick, W.S.	1838
Cheyne, James Auchinleck, of Kilmaron	1825
Chiene, George Tod, Factor for Islay	1838
Chiene, Patrick, Edinburgh	1820
Chisholm, Duncan Macdonell, of Chisholm	1839
Chisholm, John, of Stirches	1839
Chisholm, Lachlan, of Lochans	1831
Chivas, Alexander, Agent at Aberdeen for the National Bank of Scotland	1840
Chrisp, James, Newcastle-upon-Tyne	1838
Christie, Charles Maitland, of Durie	1841

	Admitted
Christie, James, Hillend, H.E.I.C.S.	1835
Christie, John, of Pitgorno	1843
Christie, John, Goldie Lea, Dumfries	1846
Christie, Robert, Accountant, Edinburgh	1824
Christie, William Macpherson, Ballimore	1837
Christopher, Robert Adam, M.P.	1825
Chrystie, Captain Alexander, H.E.I.C.S.	1834
Chrystie, Captain Thomas, R.N.	1841
Church, James, junior, Tower of Sark	1838
Clapperton, Alexander, Merchant, Edinburgh	1838
Clapperton, Thomas, of Spyelaw, Merchant, Edinburgh	1837
Clark, Francis William, of Ulva	1838
Clark, James, of Boxton	1834
Clark, James, Wormiston	1842
Clark, Robert, Hanover Street, Edinburgh	1845
Clarke, Alexander, Eriboll, Tongue	1847
Clarke, Dr. John, of Speddoch, M.D., K.H., Deputy Inspector General of Army Hospitals	1838
Clason, Andrew, W.S.	1820
Clason, Rev. Dr. Patrick, Edinburgh	1838
Clayhills, Alexander, of Invergowrie	1838
Cleghorn, George, of Weens	1821
Cobb, William, Mains of Fintray	1843
Cobbold, Charles, Broughton Park	1842
Cobbold, Robert Knipe, Carlton Rookery, Suffolk	1844
Cogan, Hugh, Merchant, Glasgow	1838
Cogan, John, Merchant, Glasgow	1838
Cogan, Robert, Merchant, Glasgow	1830
Coldwells, John, Stobmills, Fushie Bridge	1845
Collie, James, Farmer, Middleton of Fintry	1840
Collier, John, Hatton, Carnoustie	1843
Collier, Thomas, Hatton, Factor to the Right Hon. Lord Panmure	1835
Collier, William, Merchant, Dundee	1843
Colquhoun, John, Advocate, Sheriff of Dumbartonshire	1807
Colquhoun, John Campbell, of Killermont, M.P.	1824
Colquhoun, William Hanson, Sheriff-Substitute, Inverness	1839
Colquhoun, William Lawrence, of Clathick	1838
Colt, John Hamilton, of Gartsherrie	1844
Colville, William, of Laws, Dundee	1843
Condie, James, Blackfriar's House, Perth	1839
Connal, William, Merchant, Glasgow	1838
Connell, James, of Conheath	1843
Constable, James Nicoll, of Calley	1843
Cook, John, W.S.	1841
Cooper, Henry R., of Ballindalloch	1845

	Admitted
Cooper, William, of Failford	1845
Copland, David, Merchant, Aberdeen	1833
Copland, William, of Collieston	1836
Cordiner, William F., of Memsie, Fraserburgh	1841
Corrie, Hugh, younger of Steilston	1844
Corrie, Thomas, of Culloch, Manager British Linen Co.	1826
Coulter, John, Tylefield, Glasgow	1833
Couper, Peter, W.S.	1811
Cowan, Alexander, Merchant, Edinburgh	1810
Cowan, Charles, Valleyfield	1836
Cowan, David, York Place, Edinburgh	1844
Cowan, Duncan, Merchant, Edinburgh	1810
Cowan, James G., Drummond Place, Edinburgh	1840
Coventry, Andrew, of Pittillock, Advocate	1814
Craig, Alexander, Merchant, Edinburgh	1818
Craig, Alexander, Kirkton	1821
Craig, James, Surgeon, Ratho	1841
Craig, John, Merchant, Edinburgh	1818
Craig, William Gibson, younger of Riccarton, M.P.	1824
Craigie, David, Cashier, Perth Banking Company	1842
Craigie, Lawrence, of Glendoick	1824
Cranstoun, George, of Corehouse	1819
Craufurd, James, younger of Ardmillan, Advocate	1835
Craufurd, William Houison, of Craufurdland	1809
Crawford, Charles, East Fortune	1822
Crawford, David, Writer, Greenock	1844
Crawford, John Innes, of Bellfield	1815
Crawford, John, of Auchinames	1818
Crawford, John, late British Resident at Java	1819
Crawford, William, of Doonside	1836
Crawford, William Macknight, of Cartsburn	1809
Crawford, W. S. S., of Milton	1838
Crichton, David Maitland Makgill, of Rankeillor	1826
Crichton, Hew, Park Place, Edinburgh	1838
Crichton, John, M.D., of West Grange of Connon	1843
Crichton, Thomas, Provost of Dumfries	1845
Crichton, Thomas, of Auchinskeoch	1795
Crombie, Alexander, of Thornton	1835
Crombie, Lewis, London	1834
Crooks, John, of Leven	1838
Crosbie, Robert, of Kepp, Merchant, Liverpool	1845
Cruickshank, Alexander, of Keithock	1836
Cruickshank, Anthony, Aberdeen	1847
Cross, David, Seed-Merchant, Glasgow	1845
Crum, Walter, of Thornliebank	1844
Crum, John, Thornliebank	1845

	Admitted
Cumine, James, of Rattray	1847
Cumming, Alexander, Merchant, Inverness	1839
Cumming, Alexander Penrose Gordon, yr. of Altyre and Gordonston	1846
Cumming, James, Factor to Sir William Maxwell of Monreith, Bart.	1841
Cumming, Lachlan, Comptroller of Customs, Inverness	1839
Cunningham, Alexander, of Balgonnie	1841
Cunningham, Alexander, Morebattle Tofts	1841
Cunningham, Alexander, of Craigends	1844
Cunningham, Colonel John, of Newton	1829
Cunningham, John, of Duchrae	1830
Cunningham, John Sinclair, Banker, Edinburgh	1833
Cunningham, John Smith, of Caprington	1835
Cunningham, Thomas Smith, younger of Caprington	1835
Cunningham, William, of Lainshaw	1810
Cunningham, William, of Goodleyburn	1830
Cunningham, William, of Craigends	1828
Cunningham, William A., of Logan	1836
Currie, Alexander, Advocate, Sheriff of Banffshire	1836
Currie, William, of Linthill	1832
Cuthbertson, Allan, Accountant, Glasgow	1844
Cuthbertson, Archibald, Greendykes	1822
Cuthbertson, Donald, Accountant, Glasgow	1827
Cuthbertson, William, Merchant, Glasgow	1836

D

Decazes, The Duc, Peer of France, President of the Council of Agriculture, Honorary Member	1836
Douglas and Clydesdale, The Most Noble William Anthony Alexander, Marquis of	1834
Ducie, Right Hon. Thomas, Earl of	1843
†Dalhousie, The Right Hon. James, Earl of	1835
Dalmeny, The Right Hon. Archibald, Lord, M.P.	1833
Duncan, Right Hon. Adam Viscount, M.P.	1843
†Dunfermline, The Right Hon. James, Lord	1834
Douglas, The Right Hon. Lord Wm. R. Keith, of Denino	1819
Duff, General the Hon. Sir Alexander, of Delgaty	1814
Dalyell, Sir John Graham, of Binns, Bart.	1807
Dunbar, Sir William, of Mochrum, Bart.	1845
Dalrymple, Sir Hew, of North Berwick, Bart.	1841
Dunbar, Sir Archibald, of Northfield, Bart.	1794
Dunbar, Sir George, of Hempriggs, Bart.	1839
Dunbar, Sir David, of Dunira, Bart.	1828
Drummond, Sir James Walker, of Hawthornden, Bart.	1834
Drummond, Vice-Admiral Sir Adam, of Megginch	1822

	Admitted
D'Este, Colonel Sir Augustus Frederick	1822
Dalgairns, Lieutenant-Colonel, of Balgavies	1841
Dalgliesh, A. Stephenson, Merchant, Glasgow	1838
Dalrymple, James Elphinstone, of Westhall	1840
Dalrymple, North, of Cleland and Fordel	1843
Dalrymple, John, yr. of Cleland and Fordel, M.P.	1845
Dalzell, James Allen, Whitehouse	1835
Darling, William, Stircoke, Caithness	1839
Darroch, General Duncan, of Gourock	1830
Darroch, Major Duncan, yr. of Gourock	1840
Daubeny, Robert Henry, of Bristol	1826
Davidson, David, Merchant, Pulteneytown	1839
Davidson, Duncan, of Tulloch	1824
Davidson, Duncan, of Inchmarlo	1824
Davidson, Henry M., Haddington	1841
Davidson, Hugh, Chief Magistrate of Thurso	1839
Davidson, James, of Ruchill, Merchant, Glasgow	1838
Davidson, Lawrence, W.S.	1829
Davidson, Patrick, yr. of Inchmarlo	1834
Davidson, Robert, Advocate	1819
Davidson, William, of Kebbaty	1841
Davidson, William, Stanstill	1833
Davidson, William, Writer, Glasgow	1838
Deans, John, Penston, Tranent	1841
Deas, George, Advocate	1838
De Lisle, Robert, of Acton Park, Yorkshire	1838
Dempster, George, of Skibo	1823
Dennistoun, William, Oakmount, Lasswade	1841
Dennistoun, James R., Merchant, Glasgow	1838
Dennistoun, John, M.P.	1838
Denny, Peter, Provost of Dumbarton	1838
Denoon, David, Solicitor, Inverness	1839
Dewar, Alexander Cumming, Vogrie, H.E.I.C.S.	1832
Dewar, James, of Vogrie	1842
Dewar, John, Advocate	1830
Dick, John, Advocate	1827
Dick, Professor, Veterinary College, Edinburgh	1840
Dick, William, of Pitkerro	1828
Dickson, Archibald, of Huntlaw	1823
Dickson, George, of Huntlaw	1830
Dickson, Henry Gordon, W.S.	1846
Dickson, James Wardrobe, Advocate, Sheriff-Substitute, Falkirk	1834
Dickson, John, of Peelwalls	1838
Dickson, John, Saughton Mains, Edinburgh	1844
Dickson, John, W.S.	1846

	Admitted
Dickson, Walter, of Monybuie, W.S.	1842
Dirom, Lieut.-Colonel John, of Mountannan	1838
Dixon, William, of Govanhill, Merchant, Glasgow	1827
Dodd, William, Merchant, Glasgow	1837
Dodds, John, Factor to the Earl of Stair	1844
Donaldson, James, of Keppoch	1845
Donaldson, John, of Auchairn, W.S.	1812
Donaldson, John, Advocate	1835
Dougal, John, of Glenferness	1844
Dougall, William Stark, of Scotscraig	1844
Douglas, Archibald, of Adderstone	1822
Douglas, Archibald, of Glenfinart	1836
Douglas, Francis Brown, Advocate	1839
Douglas, George, Advocate, Sheriff of Kincardinshire	1800
Douglas, James, of Cavers	1835
Douglas, Laurence B., Sheriff-Substitute of Fifeshire	1846
Douglas, Robert Johnstone, of Lockerbie	1842
Douglas, Thomas Dunlop, of Dunlop	1838
Dove, William, Baillieknow, Kelso	1845
Downie, Alexander, Merchant, Glasgow	1835
Downie, John, Merchant, Glasgow	1838
Drimmie, Daniel, Panmure Bleachfield, Dundee	1843
Dron, William, of Blackruthven	1829
Drummond, George Harley, late of Drumtochty	1810
Drummond, Henry Home, of Blair Drummond, M.P.	1809
Drummond, George Home, younger of Blair Drummond	1835
Drummond, John George Home, of Abbotsgrange and Millearn	1835
Drummond, Thomas, of Newton	1828
Drummond, William, Banker, Cupar Fife	1837
Dudgeon, John, Spylaw, Kelso	1840
Dudgeon, Robert, Merchant, Liverpool	1828
Dudgeon, William, Merchant, Leith	1826
Duff, Alexander, W.S.	1842
Duff, Rev. David, Minister of Kenmore	1839
Duff, Garden, of Hatten	1814
Duff, James, yr. of Delgaty, M.P. for Banffshire	1840
Duff, James Grant, of Eden	1828
Duff, Robert, of Fetteresso	1823
Duff, Richard Wharton, of Orten	1805
Duff, Thomas Abercromby, of Haddo	1835
Dunbar, Archibald, younger of Northfield	1839
Dunbar, Major P., of Mountcoffer	1823
Duncan, Alexander, of Glendivine	1824
Duncan, George, M.P.	1843
Duncan, George, Balchrystie, Fifeshire	1838

	Admitted
Duncan, James, Cargill	1826
Duncan, James, Merchant, Leith	1826
Duncan, Rev. James, Denholm, Hawick	1845
Duncan, John, Manufacturer, Aberdeen	1840
Dundas, David, of Ochtertyre, Q.C., M.P. for the County of Sutherland	1846
Dundas, Gabriel Hamilton, late of Duddingston	1823
Dundas, George, Sheriff of Selkirkshire	1846
Dundas, Captain Henry, R.N.	1842
Dundas, Lieut.-Colonel Thomas, of Carronhall	1839
Dunlop, Alexander, Advocate	1828
Dunlop, Andrew, W.S.	1841
Dunlop, Anthony, of Balnakeil	1840
Dunlop, Archibald, 42, Ebury Street, London	1823
Dunlop, Campbell, late Enterkine House	1832
Dunlop, Henry, of Craigton	1838
Dunlop, James, of Annanhill	1824
Dunlop, James, of Macnairston, W.S.	1823
Dunlop, James, of Doonside	1844
Dunlop, James, of Arthurlee	1844
Dunlop, John, of Brockloch	1836
Dunlop, William, Hailles Cottage, Edinburgh	1846
Dunn, William, of Duntocher, Merchant, Glasgow	1827
Dunsmure, James, late Secretary Herring Fishery Board	1817
Duthie, Alexander, Advocate, Aberdeen, Secretary Aberdeen, Banff, Kincardine and East Forfar Agricultural Society	1847
Dykes, Fretcheville Lawson Ballantyne, of Dovenby Hall, Cumberland	1845
Dyson, Thomas C., of Willowfield, Halifax, Yorkshire	1832

E

ESTERHAZY, His Highness the Prince, Hungary, Honorary Member	1836
ELLESMERE, Right Hon. Francis, Earl of	1822
†EGLINTON, The Right Hon. Archibald, Earl of	1834
ELGIN and KINCARDINE, The Right Hon. James, Earl of	1842
†ELIBANK, The Right Hon. Alexander, Lord	1836
ELCHO, The Right Hon. Francis, Lord	1819
ELPHINSTONE, The Right Hon. John, Lord	1834
EMLYN, The Right Hon. John Frederick, Viscount, M.P.	1839
ELPHINSTONE, The Hon. Mountstuart	1833
ELIOTT, Sir William Francis, of Stobbs, Bart.	1823
EDMONSTONE, Sir Archibald, of Duntreath, Bart.	1821
ELPHINSTONE, Sir Robert Dalrymple Horn, of Horn and Logie-Elphinstone Bart.	1813

	Admitted
Eccles, William, Merchant, Glasgow	1838
Eddington, Smollett Montgomery, of Glencreggan	1844
Edington, John, Cameron, Windygates	1845
Edmonstone, Archibald, Architect and Builder, Glasgow	1838
Edmonstone, Charles, of Cardross Park	1838
Edmonstone, Thomas, of Buness, Zetland	1838
Edward, Allan, Merchant, Dundee	1843
Edwards, James, Flax-spinner, Dundee	1844
Elder, John, Merchant, Slate	1815
Ellice, Edward, M.P.	1836
Elliot, George Scott, Woodslee	1813
Elliot, James, of Wolflie	1826
Elphinstone, Lieutenant-Colonel John	1827
Erskine, Alexander, of Bellhall and Longhaven	1843
Errington, Rowland, of Sandhoe	1841
Erskine, James, of Cambus	1808
Erskine, John Francis, Broomrigge, Dollar	1845
Erskine, Thomas, Linlathen, Broughty-Ferry	1843
Ewart, Archibald, Depute-Clerk of Chancery	1839
Ewing, Alexander, of Tartowie, M.D., Aberdeen	1841
Ewing, Alexander, Woodside Place, Glasgow	1844
Ewing, James, of Strathleven	1827
Ewing, James Lindsay, of Caldercruix	1844
Ewing, John Orr, Croft, Dumbarton	1838
Ewing, Robert, Merchant, Greenock	1830
Ewing, William Leckie, of Arngomery	1835

F

†Fife, The Right Hon. James, Earl of, K.T.	1805
Forbes, The Right Hon. Walter, Lord	1833
Fitzclarence, The Right Hon. Lord Frederick	1841
Flahault, Charles, Count Mercer De	1821
Forbes, Sir John Stuart, of Pitsligo and Fettercairn, Bart.	1830
Fairlie, Sir John Cuninghame, of Fairlie and Robertland, Bart.	1844
Foulis, Sir William Liston, of Colinton, Bart.	1843
Fergusson, Sir Charles Dalrymple, of Kilkerran, Bart.	1826
Forbes, Sir Charles, of Newe and Edinglassie, Bart.	1814
Forrest, Sir James, of Comiston, Bart.	1805
Ferguson, Sir Adam, Kt., Keeper of the Regalia	1799
Fraser, Major-General Sir Hugh, of Braelangwell, K.C.B.	1839
Fairbairn, T., late of St. Vincent's	1802
Fairlie, James, of Holmes	1827
Fairlie, James Ogilvie, of Coodham	1836
Falconer, George, of Carlowrie	1837

	Admitted
Falconer, Cosmo, of Hartwoodhill	1805
Farquhar, Nathanael, Advocate, Aberdeen	1840
Farquharson, Andrew, yr. of Whitehouse, Aberdeen	1840
Farquharson, Major-General Francis, H.E.I.C.S.	1843
Farquharson, James, of Invercauld	1831
Farquharson, John, of Haughton	1808
Farquharson, Major John, of Corrachrie, Tarland	1841
Farquharson, Peter of Whitehouse	1833
Farquharson, Robert, of Allargue	1845
Farquharson, Thomas, of Baldovie	1836
Fector, J. Minet, London	1840
Fenton, John, Mill of Mains, Dundee	1843
Fergus, John, of Strathore	1832
Ferguson, Captain George, of Pitfour, R.N.	1828
Ferguson, James, of Kinmundy	1826
Ferguson, John, late of Stronvar	1805
Ferguson, John, of Knockindale	1824
Ferguson, John, Kilquhanity, Kirkpatrick-Durham	1846
Ferguson, John, Coynach, Mintlaw, Secretary Buchan Agricultural Association	1847
Fergusson, Adam, of Woodhill, Member of the Honourable Legislative Council of Canada	1807
Fergusson, James, W.S.	1826
Fergusson, Lieut.-Colonel James, of Huntly Burn	1831
Fergusson, John, Wine Merchant, Leith	1826
Ferguson, John, Wine-Merchant, Inverness	1839
Ferguson, Lieut.-Colonel Robert, of Raith, M.P.	1845
Fergusson, Muir, of Middlehaugh	1842
Fergusson, Samuel, R., W.S.	1836
Fernie, James Blyth, of Kilmux	1836
Ferrie, John, Merchant, Greenock	1831
Ferrier, Alexander, late Bloomhill, Dunbarton	1838
Ferrier, Charles, of Baddingsgill, Accountant, Edinburgh	1833
Ferrier, John, W.S.	1796
Findlay, Robert, of Easterhill, Banker, Glasgow	1838
Findlay, Robert, of Butturich	1844
Findlay, Thomas Dunlop, Easterhill	1847
Finlay, Alexander Struthers, of Castle Toward	1844
Finnie, John, Swanston	1838
Fisher, Daniel, S.S.C.	1819
Fisher, James, M.D., late Staff Surgeon to the Army in Canada	1821
Fleming, Lieutenant-Colonel, of Inistore	1839
Fleming, Robert, Bath Street, Glasgow	1838
Fleming, William Malcolm, of Barrochan	1832

	Admitted
Flemying, Robert Stewart, of Killiehassie	1826
Fletcher, Angus, of Dunans, Advocate	1826
Fletcher, Angus, Sculptor, Cawara	1842
Forbes, Alexander, of Boyndlie	1840
Forbes, Alexander, Inverernan	1840
Forbes, Charles, of Asloun	1828
Forbes, Charles Henry, of Kingerloch	1836
Forbes, George, Banker, Edinburgh	1817
Forbes, George, Merchant, Fitzroy Square, London	1830
Forbes, George, Wine-Merchant, Edinburgh	1835
Forbes, James D., Professor of Natural Philosophy in the University of Edinburgh	1836
Forbes, James Stewart	1830
Forbes, John, of Inverernan, H.E.I.C.S.	1842
Forbes, Lieutenant-General Nathanael, of Auchernach	1828
Forbes, Patrick, of St. Catherine's	1834
Forbes, Peter, Wine-Merchant, Edinburgh	1838
Forbes, William, of Callender, M.P.	1830
Forbes, William, younger of Medwyn, Advocate	1835
Fordyce, Captain Dingwall, of Brucklay	1847
Fordyce, Thomas J., late of Ayton	1828
Forlong, William, of Erins	1838
Forman, John Nairn, W.S.	1831
Forrest, James, Junior, Kirriemuir	1843
Forrester, John, W.S.	1842
Forrester, W. A., of Barns	1842
Forsyth, James, of Dunach	1838
Forsyth, John, Forres	1826
Foulds, William, of Skirnieland	1833
Fowler, Henry Mackenzie, of Fairburn and Raddery	1846
Fox, George Lane, of Bramham Park	1842
Fox, Richard M., of Foxhall, Rathowen, Ireland	1838
Fraser, Affleck, Inverness	1840
Fraser, Alexander, City Chamberlain, Aberdeen	1841
Fraser, Andrew, W.S., Sheriff-Substitute, Fort-William	1840
Fraser, Captain Alexander, Royal Engineers	1818
Fraser, Major Andrew, of Flemington	1837
Fraser, Archibald Thomas Frederick, of Abertarf	1820
Fraser, Colonel Charles, of Inverallochy and Castle Fraser	1816
Fraser, Evan Bailie, of Inchcoulter	1840
Fraser, Hugh, Abersky	1840
Fraser, James B., of Relig	1839
Fraser, Captain James, of Ballindown	1839
Fraser, John, Cashier, Cullen House	1812

	Admitted
Fraser, John, York Terrace, London	1840
Fraser, John, Tacksman of Clury, Strathspey	1840
Fraser, John, Dumfries	1843
Fraser, Robert, Brackla, Nairnshire	1839
Fraser, Capt. Thomas, of Balnain, R.N.	1839
Fraser, Dr. Thomas, Fasnakyle	1840
Fraser, Capt. William, Brackla	1809
Fraser, William, of Glenmead, W.S.	1816
Fraser, Lieut.-Colonel William, of Balmakewan	1838
Fraser, William, of Hillside and Skipness	1838
Fraser, William, junior, W.S.	1837
Freeland, Robert, of Gryffe Castle, Merchant, Glasgow	1835
Fullarton, Archibald, of Kilmichael	1846
Fullerton, Gavin, of Kerelaw	1844
Fullerton, Captain James, 30th Regiment	1824
Fyfe, Andrew, M.D., Professor of Chemistry, King's College, Aberdeen	1823
G	
GORDON, Her Grace Elizabeth, Duchess of	1834
GALLOWAY, The Right Hon. Randolph, Earl of	1830
GLASGOW, The Right Hon. James, Earl of	1822
GIFFORD, The Right Hon. George, Earl of	1846
GRAY, The Right Hon. John, Lord	1821
GRAHAM, The Right Hon. Lord Montague William	1831
GRAHAM, The Right Hon. Sir James Robert George, of Netherby, Bart., M.P.	1830
GORDON, Rear-Admiral, The Hon. William, R.N., M.P.	1824
GORDON, The Right Hon. Sir Robert, Balmoral, G.C.B.	1834
GIBSON, Sir Alexander C. Maitland, of Cliftonhall, Bart.	1818
GRANT, Sir John Macpherson, of Ballindalloch and Invereshie, Bart.	1827
GLADSTONE, Sir John of Fasque, Bart.	1833
GRANT, Sir John Peter, of Rothiemurchus, Knight, Judge in the Supreme Court, Calcutta	1792
Galbraith, John, younger of Buckieburn	1838
Galbraith, William, of Blackhouse, Sheriff-Clerk of Stirlingshire	1822
Galbreath, David Stewart, of Machrihanish	1812
Gallaway, William, Accountant, Edinburgh	1814
Garden, Alexander, Merchant, Glasgow	1827
Gardiner, John, Smithston	1830
Gardner, Hamilton Gray, W.S.	1844
Gardner, John, of Springbog	1844
Gardner, Richard, of Dudhope	1841
Gardyne, Major William Bruce, of Middleton	1843

	Admitted
Gartshore, John Murray, of Gartshore	1825
Geddes, Adam G., Paymaster, late 3d Garrison Battalion, Newington	1819
Geddes, James, Orbliston	1843
Geddes, Lieut-Col. John, K.H.	1842
Geekie, Alexander, of Baldourie	1837
Geekie, Peter, Factor for the Earl of Mansfield at Scone	1837
Geekie, Robert, of Rosemount	1843
Geils, John Edward, of Dumbuck	1844
Gentle, Robert, Dell, Inverness-shire	1840
Gerard, Archibald, of Rochsoles	1842
Gerard, John Mair, of Midstrath	1834
Gibb, Elias, Merchant, Glasgow	1838
Gibbon, Alexander, of Johnston	1834
Gibbons, Edward, Factor to Macleod of Macleod	1830
Gibbs, Humphrey	1840
Gibson, Alexander Carmichael, younger of Castlecraig	1836
Gibson, John, W.S.	1825
Gibson, John, Jun., W.S.	1828
Gibson, Thomas, of Spittal, M.D.	1845
Gilchrist, Daniel, of Ospisdale	1841
Giles, James, of Kailzie	1842
Gilbert, John Graham, of Yorkhill	1847
Gilfillan, James, of Cowdenknows	1841
Gillanders, F. M., of Newmore	1844
Gillespie, Alexander, M.D., Edinburgh	1806
Gillespie, Alexander, Merchant, Gould Square, London	1836
Gillespie, David, of Mountquhannie	1841
Gillespie, John, W.S.	1846
Gillespie, Robert, Merchant, London	1829
Gillespie, Robert, of Cambus-Wallace	1842
Gillespie, Thomas, Park Hall	1842
Gillespie, Thomas, of Ardochy	1821
Gillespie, William, Gateside	1829
Gilmour, Walter James Little, of Craigmillar	1828
Gilmour, William, of Oatlands, Merchant, Glasgow	1838
Gilmour, William, Maryland	1844
Gilly, Rev. William Stephen, D.D., Vicar of Norham	1841
Girdwood, John, Chirk, North Wales	1845
Gladstone, Robertson, Merchant, Liverpool	1841
Gladstone, Thomas, yr. of Fasque	1834
Glasgow, R. Robertson, of Mountgreenan, Advocate	1838
Glen, Alexander, of Demerara	1841
Glen, John, Merchant, Edinburgh	1847
Goalen, Alexander, Star Bank, Newhaven	1805

	Admitted
Goldie, Alexander, of Broomlee, W.S.	1822
Goldie, Rev. Thomas S., Coldstream	1833
Gollan, John, of Gollanfield	1839
Goodsir, John, Professor of Anatomy in the University of Edinburgh	1846
Goodwin, Lieutenant-Col. Hugh Maxwell, of Mount Alyn, Denbighshire	1830
Gordon, Alexander, of Ellon	1808
Gordon, Alexander, George Square, Edinburgh	1817
Gordon, Alexander, of Newton	1841
Gordon, Charles Napier, of Esslemont	1840
Gordon, Charles, of Auchluchries	1832
Gordon, Captain Charles, R.N.	1835
Gordon, Edward Stratherne, Advocate, Edinburgh	1840
Gordon, Francis, yr. of Abergeldie	1841
Gordon, Francis, of Kincardine	1835
Gordon, George, Muiryfold	1829
Gordon, James, of Manar	1835
Gordon, James, Revack, Ivy Bank	1813
Gordon, James, of Xeres-de-la Frontera	1834
Gordon, James Adam, of Knockespock	1843
Gordon, John, of Avochie	1846
Gordon, John Thomson, Advocate, Sheriff of Aberdeenshire	1841
Gordon, Colonel John, of Cluny	1807
Gordon, John, of Aikenhead	1838
Gordon, John David, of Wardhouse	1828
Gordon, John, of Cairnbulg, Advocate	1811
Gordon, John, late Major of the 2d or Queen's Regiment	1822
Gordon, John, Tacksman of Croughly and Campdalemore	1839
Gordon, John Taylor, of Nethermuir and Blackhouse	1831
Gordon, Joseph, W S.	1804
Gordon, Michael Francis, of Abergeldie	1831
Gordon, Peter Charles, yr. of Wardhouse	1834
Gordon, Peter Laing, of Craigmyle	1834
Gordon, Richard, Accountant, Edinburgh	1845
Gordon, Robert, of Jamaica	1802
Gordon, Robert Macartney, of Rattra	1846
Gordon, Lieutenant-Colonel Thomas, of Park	1825
Gordon, William, of Culvennan	1845
Gordon, Major-Gen. W. A., late 50th Regiment, C.B.	1818
Gordon, Captain William, H.E.I.C.S., Newton	1828
Govan, John, W.S.	1809
Gracie, John Black, W.S.	1834
Græme, Major George Drummond, of Inchbraikie	1839
Graham, Colonel David, of Meiklewood	1831

	Admitted
Graham, Frederick, late Factor to the Duke of Atholl	1821
Graham, Alexander, of Capilly	1844
Graham, Charles Maxwell, Glasgow	1844
Graham, George, late of Cassafuar	1817
Graham, George, of Shaw	1826
Graham, Henry, Surgeon, Shandwick Place, Edinburgh	1839
Graham, Humphrey, W.S.	1819
Graham, James, of Leitchtown	1827
Graham, James Gillespie, of Orchill	1806
Graham, James, of Fereneze	1843
Graham, James Maxwell, Glasgow	1844
Graham, John, Newbigging	1829
Graham, John, of Pearsie, Kirriemuir	1843
Graham, Patrick, of Limekilns	1836
Graham, Robert, of Balgowan	1817
Graham, Robert, Merchant, Leith	1826
Graham, Robert Stirling, of Kincaldrum	1841
Graham, William Stirling, of Airth	1833
Graham, William, Writer, Glasgow	1828
Graham, Lieut.-Colonel William, of Mossknow	1834
Graham, William, jun. of Finnartmore	1844
Graham, Robert C. Cuningham, of Gartmore	1823
Grainger, John, Factor to the Marquis of Lothian, at Mounteviot	1836
Grainger, Thomas, Civil Engineer, Edinburgh	1841
Grant, Alexander, of Aberlour	1810
Grant, Major Charles, Aberdeen	1816
Grant, Dougal, York Place, Edinburgh	1833
Grant, Duncan, of Bught	1825
Grant, George, Liverpool	1840
Grant, George, Advocate	1846
Grant, James M., of Glenmoriston and Moy	1810
Grant, Rev. James, D.D., St. Mary's Church, Edinburgh, Chaplain to the Society	1828
Grant, James Augustus, of Viewfield	1840
Grant, John, of Kilgraston	1819
Grant, John Peter, W.S.	1823
Grant, Lewis, Kincorth, Morayshire	1846
Grant, Patrick, W.S., Sheriff-Clerk of Inverness-shire	1836
Grant, Robert, of Kincorth	1826
Grant, Robert, of Tillyfour	1830
Grant, Robert, of Craighall	1841
Grant, Robert, Bookseller, Edinburgh	1842
Grant, Thomas Macpherson, W.S.	1846
Grant, Walter Colquhoun, Captain Royal Scots Greys	1844
Grant, William, younger of Elchies	1833

	Admitted
Grant, W. P., younger of Rothiemurchus	1821
Grant, William, Tacksman of Ruthven, Banffshire	1839
Grassick, Charles, of Tillypronie	1830
Grassick, John, Mains of Glenbucket	1829
Grassick, Patrick, Littlewood Park	1842
Gray, Andrew Farquhar, of Glentig, Comptroller of the Customs, Glasgow	1835
Gray, Charles, Distiller, Glasgow	1838
Gray, James, of Auchingeich	1843
Gray, John, Merchant, Greenock	1831
Gray, Roderick, Factor at Peterhead for the Merchant Hospital of Edinburgh	1829
Gray, Stephen, of Mansfield	1838
Gray, William, of Blairbeth, Goldsmith, Glasgow	1838
Gray, William, Merchant, Glasgow	1838
Greenhill, David, Grant Lodge	1842
Gregorson, John, late of Ardtornish	1805
Gregory, Arthur Thomas, of Buchromb	1833
Gregory, William, M.D., Professor of Chemistry in the University of Edinburgh	1845
Gregg, James, Advocate, Sheriff-Substitute and Joint-Convener of Caithness	1839
Greig, James, of Eccles, W.S.	1809
Greig, James, junior, W.S.	1841
Greig, John, of Lethangie	1833
Greig, John, younger of Lethangie	1846
Grieve, Andrew, W.S.	1838
Grieve, James, Branxholm Braes	1842
Grieve, Thomas, Skelf-hill, Roxburghshire	1839
Grieve, William, of Branxholm Park	1834
Grindlay, Richard, Merchant, Leith	1842
Gulland, William Erskine, of Stripeside	1833
Gunn, George, Factor on the Estate of Sutherland	1821
Gunn, James, Glendhue, Sutherland	1839
Gunn, William, Glendhue	1839
Guthrie, George, Factor to the Earl of Stair, Wigtonshire	1839
Guthrie, John, of Guthrie	1836
Guthrie, John, younger of Guthrie	1836
Guthrie, Major, Perth	1826
Gwynne, Alban Thomas Jones, of Monachty, Cardiganshire	1834

H

*Hamilton and Brandon, His Grace Alexander, Duke of, K.G.	1804
†Huntly, The Most Noble George, Marquis of, K.T.	1793

	Admitted
HOME, The Right Hon. Cospatrick, Earl of	1843
†HADDINGTON, The Right Hon. Thomas, Earl of	1804
HAY, The Right Hon. Lord John, Captain R.N.	1824
HAY, Major-General, The Right Hon. Lord James	1847
HALLYBURTON, The Right Hon. Lord John Frederick Gordon, M.P.	1844
HOPE, The Right Hon. Charles	1793
HOPE, The Right. Hon. John, Lord Justice-Clerk	1823
HASTIE, The Hon. Alexander, Lord Provost of the City of Glasgow	1843
HEPBURN, Sir Thomas Buchan, of Smeaton Hepburn, Bart. M.P.	1837
HOPE, Sir John, of Craighall, Bart.	1808
HAY, Sir Adam, of Smithfield and Hayston, Bart.	1825
HALKET, Sir John, of Pitferrane, Bart.	1842
HALL, Sir John, of Dunglass, Bart.	1829
HAY, Sir James Dalrymple, of Park Place, Bart.	1816
HAY, Sir A. Leith, of Rannes, M.P.	1819
HOUSTON, Major-General Sir Robert, of Clerkington, K.C.B.	1833
Hadden, Alexander, of Persley	1840
Hagart, Thomas, of Bantaskine	1826
Haggart, James Valentine, of Glendelvine	1844
Haig, Alexander, of Blairhill	1833
Haig, John, Cameron Distillery, Kirkaldy	1841
Halket, Charles Craigie, of Hallhill	1834
Hall, Henry, Coul, Dornoch	1846
Hall, James, of Kilean, Argyllshire	1839
Hall, John, Scibercross, Golspie	1841
Hall, John, of Mollance	1841
Hamilton, Archibald, of Carcluie	1833
Hamilton, James, of Kames, W.S.	1807
Hamilton, James, of Barns	1828
Hamilton, John, of Sundrum	1839
Hamilton Lieut.-Col. John Ferrier, of Westport and Cairnhill	1827
Hamilton, John, of Fairholm	1827
Hamilton, John, yr. of Greenbank	1846
Hamilton, John Buchanan, of Leny and Bardowie	1846
Hamilton, Montgomerie, late Captain, H.E.I.C.N.S.	1836
Hamilton, Lieut.-Colonel R. Campbell, of Milburn and Dalserf	1804
Hamilton, Robert, W.S., Tiretigan	1842
Hamilton, Robert William, Agent, General Steam Navigation Company, Edinburgh	1814

	Admitted
Hamilton, William, Merchant, Glasgow	1823
Hamilton, William, of Craighlaw	1829
Hamilton, William, of Lonsdale	1846
Handyside, Robert, Advocate, Sheriff of Stirlingshire	1841
Handyside, William, of Kirklands	1843
Hanny, John, Dalquhairn, Dumfries	1840
Hanning, John, Meikle Knox	1840
Harden, Robert Allan, Doune Terrace, Edinburgh	1838
Harthill, John, Waterloo Place, Edinburgh	1846
Harvey, Archibald, of Killelan, Merchant, Glasgow	1838
Harvey, Arthur, of Tillygreig	1838
Harvey, C. W., Merchant, Liverpool	1846
Harvey, Lieut.-Col. James, of Castlesemple, K.H.	1823
Harvey, John Rae Lee, younger of Castlesemple	1836
Harvey, John, of Ichwell, Bury, and Tiningly Park, Yorkshire	1809
Harvey, John Inglis, of Kinnettles, H.E.I.C.B.C.S.	1845
Harvey, Robert of Pennygowan	1845
Harvey, William, Distiller, Yoker	1838
Harvie, Robert, Distiller, Port-Dundas	1838
Hastie, Archibald, M.P.	1838
Hay, Adam, W.S.	1846
Hay, Alexander, of Hardengreen	1837
Hay, David Ramsay, House Painter to the Queen	1842
Hay, George William, of Whiterig	1841
Hay, James, of Belton, Capt. R.N.	1820
Hay, James, Merchant, Leith	1828
Hay, John, of Letham Grange	1834
Hay, John Stewart, of Rockville	1836
Hay, Robert, of Lawfield	1807
Hay, Samuel, Manager of the Union Bank of Scotland	1846
Hay, William, late of Laxfrith	1828
Hay, William, of Dunse Castle	1819
Hay, William, of Hopes	1835
Heathcoat, John, M.P., Honorary Member	1837
Hector, Alexander, Writer, Edinburgh	1824
Henderson, Alexander, Long Niddry	1837
Henderson, Alexander, of Gourdie, H.E.I.C.S.	1843
Henderson, Alexander, yr. of Stempster	1847
Henderson, Captain David, of Stempster	1829
Henderson, G. D. Clayhills, Hallyards, Perthshire	1843
Henderson, Duncan, M.D., 78th Regiment	1825
Henderson, James, Distiller, Pulteneytown	1839
Henderson, John, W.S., Wick	1839
Henderson, John, of Park	1838

	Admitted
Henderson, John Alexander, of Westerton, 4th or Queen's Own Light Dragoons	1831
Henderson, John Irving, Advocate, Sheriff-Substitute, Dundee	1823
Henderson, Robert, Merchant, Glasgow	1838
Henry, John, of Corse	1815
Hepburn, John Stewart, of Colquhalzie	1810
Hepburn, John Buchan, of Castle Dykes	1845
Herries, William Young, of Spots	1823
Heriot, John, of Foley Hills	1828
Heriot, James, of Ramornie	1800
Heron, James, of Dalmore	1833
Hewatson, Robert, Auchenbenzie	1834
Hewetson, James, Provost of Castle-Douglas	1840
Hill, Charles, of Luthrie	1842
Hill, George Gosset, Merchant, London	1823
Hill, Henry David, W.S.	1825
Hill, Lawrence, of Barlanark, Writer, Glasgow	1838
Hill, Norman, of Brownhills, Advocate	1807
Hill, Robert, of Firth, W.S.	1800
Hog, James Maitland, of Newliston and Kellie	1835
Hogarth, George, Banker, Cupar-Fife	1842
Hogarth, John, Akeld, Northumberland	1841
Home, Francis, Sheriff-Substitute, Linlithgow	1829
Home, Major-General James, of Broomhouse	1829
Home, Colonel J. H., of Bassendean, Grenadier Guards	1834
Home, John Foreman, of Wedderburn	1830
Home, William Foreman, of Billy and Paxton	1823
Hood, David, of Balluderon	1834
Hood, John, of Stoneridge	1827
Home, G. Binning, of Argaty	1831
Hope, Archibald, younger of Craighall and Pinkie	1832
Hope, Captain David, of Bridge Castle, R.N.	1846
Horn, John, of Thomanean	1837
Horne, Archibald, Accountant, Auditor of Accounts to the Society	1828
Horne, Donald, of Langwell	1817
Horne, James, yr. of Langwell, 71st Highland Light Infantry	1846
Horne, William, of Scouthell, Advocate, Sheriff of Haddington	1813
Horrocks, John, late of Tullichewan Castle	1818
Horrop, Isaac W., Altrincham, Cheshire	1846
Horsburgh, Major William Henry	1824
Horsburgh, Robert, Factor for the Duke of Sutherland, House of Tongue	1841

	Admitted
Hozier, James, of Newlands, Advocate	1822
Hotchkins, James, Castlemilk	1838
Houldsworth, Henry, of Cranstonhill	1836
Houldsworth, John, Merchant, Glasgow	1838
Houldsworth, Thomas, of Coltness	1837
Houston, Major A., younger of Clerkington	1845
Houstoun, Ludovic, of Johnstone Castle	1823
Houston, Thomas, Kintradwell	1821
Howard, Lieut.-Colonel, late North British Staff	1809
Howat, Robert Kirkpatrick, of Mabie	1841
Howden, Francis, Factor, Falkland	1842
Howden, James, Jeweller, Edinburgh	1827
Hughan, Thomas, of Airds	1838
Huggins, W. B., Glasgow	1844
Hume, Joseph, of Horndean and Lochcote	1840
Hume, Peter, Hallyburton, Lawfield, Dunbar	1840
Hunt, James, of Pittencrief and Logie	1816
Hunt, William, younger of Pittencrief and Logie	1836
Hunter, Alexander, W.S.	1824
Hunter, Andrew, of Bonnington	1819
Hunter, Charles, of Seaside and Glencarse	1823
Hunter, Captain James, younger of Glencarse	1847
Hunter, David, of Blackness	1826
Hunter, James, Templehall	1823
Hunter, Captain James, of Auchterarder	1823
Hunter, James, of Hafton	1833
Hunter, James William, of Thurston	1842
Hunter, John, Oxenford Mains	1842
Hunter, John, younger of Bonnington	1836
Hunter, Robert, Glenocher	1842
Hunter, Robert, Advocate, Sheriff of Buteshire	1843
Hunter, Richard, H.E.I.C.S.	1837
Hunter, William Hugh, Perth	1836
Hunter, William, of Ormiston	1812
Hussey, William, of Newhall, Merchant, Glasgow	1838
Hutchinson, James, Merchant, Glasgow	1838
Hutchison, Graham, Merchant, Glasgow	1838
Hutchison, John, junior, Monyruie	1841
Hutchison, Robert, Merchant, Glasgow	1838
Hutchison, Robert, of Cairngall	1829
Hutton, Thomas, Benholm, Bervie	1844
Hyett, Henry W., of Painswick	1841

I

IVORY, The Hon. Lord	1833
Inglis, David, Kincaidfieldhouse, Kirkintulloch	1845

	Admitted
Inglis, Henry Maxwell, of Loganbank, W.S.	1847
Inglis, James P., late Merchant, Leith	1806
Inglis, John, of Redhall	1825
Innes, Alexander, of Cowie	1840
Innes, Alexander Mitchell, younger of Ayton	1842
Innes, Cosmo, Advocate, Sheriff of Elginshire	1840
Innes, John B., W.S.	1847
Innes, Robert, of Thrumster	1824
Innes, Thomas Mitchell, Phantassie	1842
Innes, Thomas, of Lairney	1846
Innes, William Mitchell, of Parson's Green	1819
Innes, William, of Raemoir	1834
Ireland, William, of Barbey	1837
Irvine, Alexander Forbes, of Drum	1805
Irvine, Alexander Forbes, younger of Drum	1845
Irvine, Rev. Alexander Robertson, Minister of Foss	1838
Irvine, Patrick, of Inveramsay, W.S.	1827
Irvine, William Stewart, M.D., Pitlochrie	1843
Irving, George Vere, of Newton	1844
Irving, John, of Burnfoot	1838

J

Johnstone, The Hon. Henry Butler, of Corehead	1842
Jardine, Sir William, of Applegarth, Bart.	1823
Jardine, Sir Henry, of Harwood, Knight	1799
Jameson, Alexander, Graham Street, Edinburgh	1842
Jameson, Robert, Professor of Natural History in the University of Edinburgh	1820
Jamieson, John, Rutland Square	1844
Jardine, Andrew, of Lanrick	1846
Jardine, James, Civil-Engineer, Edinburgh	1818
Jardine, James, of Larreston	1846
Jardine, John, Advocate, Sheriff of Ross and Cromarty	1833
Jeffreys, Captain George, of Sunwick	1840
Jerdan, George, of Grange, Sec. Union Agricult. Society	1832
Jobson, Robert, Auchterhouse, Dundee	1843
Johnstone, Alexander, W.S., Aberdeen	1836
Johnston, Andrew, of Halleaths	1838
Johnston, George, Factor to the Earl of Eglinton	1822
Johnston, James F. W.	1846
Johnston, Robert, Merchant, Aberdeen	1839
Johnston, John, late Factor for the Earl of Glasgow	1833
Johnston, Rear-Admiral Charles, of Cowhill	1830
Johnstone, Alexander, W.S.,	1819
Johnstone, Charles Kinnaird, Alva, K.L.S.	1839
Johnstone, James, of Alva	1828

	Admitted
Johnstone, John James Hope, of Annandale, M.P., Honorary Secretary of the Society	1824
Johnstone, Thomas, of Underwood	1812
Johnstone, Walter, of Bodesbeck	1829
Johnstone, William, Banker, Girvan	1833
*Johnstone, William, Merchant, Greenock	1825
Johnstone, William James Hope, younger of Annandale	1845
Jollie, Walter, W.S.	1829
Jolly, David Leitch, Banker, Perth	1829
Jolly, Stewart, Chamberlain to the Duke of Montrose	1827
Jolly, William Gardiner, Catter, Chamberlain to the Duke of Montrose	1845
Jopling, Thomas, Castlelaw	1823
Jopp, Alexander, Advocate, Aberdeen	1834

K

†KINNOUL, The Right Honourable Thomas, Earl of	1806
KENMURE, The Right Honourable Adam, Viscount	1841
KINNAIRD, The Right Honourable George William, Lord	1830
KENNEDY, The Right Honourable T. F., of Dunure	1812
KINLOCH, Sir David of Gilmerton, Bart.	1828
KEIR, General Sir William Grant, K.C.B.	1804
Kaye, Robert, of Millbrae	1844
Keir, John, of Westfield	1832
Keir, Patrick Small, of Kinmonth	1805
Keir, Patrick, younger of Kinmonth	1837
Keith, Alexander, Netherthird	1837
Keith, William, Accountant, Edinburgh	1821
Kennedy, Donald, of Bogbain	1838
Kennedy, Gilbert, Glasgow	1838
Kennedy, Hugh Ferguson, of Bennand and Finnart	1832
Kennedy, John, of Kirkland	1839
Kennedy, John, of Milton Park, Ardwick House, Manchester	1830
Kennedy, John, of Underwood, W.S.	1836
Kennedy, John Lawson, younger of Knocknalling	1846
Kennedy, Primrose William, of Drumellan	1842
Kennedy, Robert Thomson, of Daljarroch	1833
Kennedy, Thomas, Nursery and Seedsman, Dumfries	1845
Kennedy, William, Factor for Sir J. M. Riddell, Bart.	1842
Ker, Captain James, of Grange and Carskerdo	1836
Kerr, Christopher, Town-Clerk, Dundee, Factor for Lord Wharncliffe	1843
Kerr, James, of Middlebank	1838
Kerr, Robert, Surgeon, Portobello	1816
Kerr, Robert, of Argrennan	1842

	Admitted
Kerr, William Scott, of Chatto	1833
Kerr, William Williamson, Oriel College, Oxford	1845
Kidston, Archibald G., Glasgow	1844
Kilgour, Robert, jun. Millbank	1826
King, Charles Alexander, of Woodnuick	1844
King, William, Manufacturer, Glasgow	1839
Kinloch, George, of Kinloch	1825
Kinloch, Colonel John, of Kilrie	1829
Kinloch, Alexander John, of Park	1841
Kinnaird, Lieut-Col. D., H.E.I.C.S., Meadow Place Edinburgh	1839
Kinnear, Charles, of Kinnear	1824
Kinnear, Patrick, of Lochton	1823
Kinnear, James, W.S.	1846
Kippen, William, of Busbie	1838
Kirk, John, Merchant, Wick	1839
Kirkaldy, George D. H., of Hearensbrooke, Eyrecourt, Ireland	1844
Kirkaldy, James, Blackness House, Dundee	1839
Knight, George, of Jordanstown	1833
Kyle, Captain Alexander, of Binghill	1835

L

LANSDOWNE, the Most Noble Henry, Marquis of, K.G., Honorary Member	1837
LORNE, the Most Noble George, Marquis of	1844
†LEVEN and MELVILLE, Right Hon. David, Earl of	1820
†LOVAT, The Right Hon. Thomas Alexander, Lord	1820
LIVINGSTONE, Rear-Admiral Sir Thomas, of West Quarter, Bart.	1815
LAWRIE, Vice-Admiral Sir Robert, of Maxwellton, Bart.	1828
LAUDER, Sir Thomas Dick, of Fountainhall, Bart.	1827
LAMB, Sir Charles, of Beauport, Bart.	1836
LOCKHART, Sir Norman Macdonald, of Lee and Carnwath, Bart.	1832
LEITH, Lieut.-General Sir Alexander, of Freefield, K.C.B.	1811
LINDSAY, Lieut.-Colonel Sir Martin, 78th Regiment	1816
L'Amy, James, of Dunkenny, Sheriff of Forfarshire	1806
Laidlaw, Robert, at Netherorsock	1833
Laing, Rev. Francis, of Carselogie	1824
Laird, David, of Strathmartin	1833
Lamond, James, of Stranduff	1827
Lamont, Alexander, of Knockdow	1819
Lamont, Archibald James, of Lamont	1840
Lamont, Robert, Writer in Glasgow	1838
Laurie, Robert, Merchant, Leith	1834

	Admitted
Law, Robert, Engineer, Shettlestone	1838
Lawson, Alexander, Merchant, Dundee	1843
Lawson, Charles, Seedsman and Conservator of the Museum of the Society	1830
Lawson, Charles, Junior, George Square, Edinburgh	1846
Lawson, John, younger of Chapleton	1832
Leadbetter, John, of Shaws	1838
Learmonth, John, of Dean	1814
Learmonth, Thomas, formerly of Lawrence Park	1824
Ledingham, Robert, Advocate, Aberdeen	1840
Legh, Rev. Peter, Golborne Park, Lancashire	1823
Leighton, William, Factor to the Duke of Hamilton	1831
Leitch, James, Merchant, Greenock	1831
Leith, Alexander, yr. of Freefield and Glenkindy	1841
Lennie, William, of Ballochneck	1836
Lennox, John L. Kincaid, of Woodhead	1824
Leslie, Angus, Pronsinain	1830
Leslie, George A. Young, of Kininvie	1840
Leslie, H. G., of Dunlugas	1826
Leslie, Jonathan, of Badenscoth	1845
Leslie, Robert, of Rothie	1845
Leslie, William, of Warthill	1826
Leny, James Macalpine, of Dalswinton	1824
Liddel, Andrew, Merchant, Glasgow	1839
Liddell, James, Auchtertool House	1843
Limond, David, of Dalblair	1832
Lindsay, Alexander K., of Balmungo	1841
Lindsay, Donald, Accountant, Edinburgh	1843
Lindsay, Colonel James, of Balcarras	1823
Lindsay, John, Corn-Merchant, Dundee	1826
Lindsay, John Mackenzie, W.S.	1840
Lizars, William Home, Old Saughton	1835
Loch, James, of Kirktomy, M.P.	1822
Lockhart, Alexander Macdonald, Carnwath	1835
Lockhart, Allan Elliot, of Borthwickbrae	1832
Lockhart, James Sinclair, yr. of Castlehill	1846
Lockhart, Norman, of Tarbrax	1815
Lockhart, William, of Milton Lockhart, M.P.	1836
Logan, Alexander, London	1831
Logan, George, W.S., Principal Clerk of Teinds	1844
Logan, Robert, of Corramore, Surgeon, New Lanark	1844
Longmore, John Alexander, W.S.	1837
Lorimer, James, of Kellyfield, Factor to the Earl of Kinnoul	1826
Lorimer, Thomas Webster, Aberdalgie, Perth	1843
Louson, David, Town-Clerk of Arbroath	1813

	Admitted
Low, Alexander, Accountant, Edinburgh	1830
Low, David, of Laws, Professor of Agriculture in the University of Edinburgh	1825
Low, James, Berrywell	1843
Low, Colonel John, C.B., H.E.I.C.S.	1844
Low, Lieut.-Col. Robert, H.E.I.C.S.	1841
Lumsdaine, Rev. Edwin Sandys, of Blanerne and Innergelly	1837
Lumsdaine, James, of Lathallan	1833
Lumsden, Benjamin, of Kingsford	1828
Lumsden, Henry, of Auchindoir	1830
Lumsden, Hugh, of Pitcaple, Sheriff of Sutherlandshire	1825
Lumsden, James, Braco, Banffshire	1840
Lumsden, James, Jun., 121, Bath Street, Glasgow	1844
Lumsden, James, Glasgow	1838
Lumsden, William-James, of Balmedie	1841
Lyall, Robert, Factor to Sir J. Carnegie, of Southesk, Bart.	182
Lyall, Robert, of Lauriston	1843
Lyell, Thomas, R.N., Kinnordy	1836
Lyon, George, of Glenogle	1809
Lyon, John, High School, Leith	1824
Lyon, John Stewart, of Kirkmichael	1837

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*MONTROSE, His Grace James, Duke of, K.T., President of the Society	1821
MARCH, Right Hon. Charles, Earl of, M.P.	1848
†MORTON, The Right Hon. George Sholto, Earl of	1828
†MORAY, The Right Hon. Francis, Earl of, K.T.	1793
†MANSFIELD, The Right Hon. David, Earl of	1833
MANSFIELD, The Right Hon. the Dowager Countess of	1840
MINTO, The Right Hon. Gilbert, Earl of, G.C.B.	1808
†MELVILLE, The Right Hon. Robert, Viscount, K.T.	1798
MACDONALD, The Right Hon. Godfrey William Wentworth, Lord	1833
MAITLAND, Rear-Admiral the Hon. Sir Anthony	1831
MAULE, The Right Hon. Fox, M.P.	1831
MAULE, The Hon. William, of Maulsden	1846
MACKENZIE, The Right Hon. Holt	1833
MACAULAY, The Right Hon. T. B., M.P.	1839
MACDONALD, The Hon. Archibald	1796
MURRAY, The Hon. Major David, Scots Fusilier Guards	1840
MACKENZIE, The Hon. Mrs. Stewart, of Seaforth	1816
MACKENZIE, The Hon. Lord	1803
MEDWYN, The Hon. Lord	1802
MONCREIFF, The Hon. Lord	1820

	Admitted
Murray, The Hon. Lord	1823
Melville, The Hon. William Leslie	1833
Moreton, The Hon. Augustus Henry Macdonald, of Largie	1844
Maxwell, Sir W. A., of Calderwood, Bart.	1830
Menzies, Sir Robert, of Menzies, Bart.	1841
Menzies, The Hon. Lady of Menzies	1839
Murray, Sir William Keith, of Ochtertyre, Bart.	1830
Maxwell, Sir John, of Pollock, Bart.	1825
Mackenzie, Sir George Stewart, of Coul, Bart.	1801
Maxwell, Sir William, of Monreith, Bart.	1840
Maxwell, Sir John Heron, of Springkell, Bart.	1839
Moncreiffe, Sir Thomas, of Moncreiffe, Bart.	1843
Miller, Sir William, of Glenlee, Bart.	1837
Mackenzie, Sir James John Randoll, of Scatwell, Bart.	1838
Mackenzie, Right Hon. Lady Anne, of Scatwell	1841
Macgregor, Sir John Atholl Bannatyne, of Macgregor, Bart.	1832
Montgomery, Sir Graham Graham, of Stanhope, Bart.	1843
Maxwell, Sir David, of Cardoness, Bart.	1810
Mackenzie, Sir John M., of Delvin, Bart.	1829
Mackenzie, Sir Evan, of Kilcoy, Bart.	1846
Menteath, Sir Charles Granville Stuart, of Closeburn-hall, Bart.	1803
Mansel, Sir John, Bart.	1840
Mactaggart, Sir John, of Ardwell, Bart., M.P.	1839
Macdonell, Lieut.-General Sir James, K.C.B.	1803
Macleod, Major-General Sir John, of Unish	1804
Macneill, Sir John, G.C.B.	1846
Munro, Sir George Gun, of Poyntzfield, Knight	1837
Macadam, John, of Blairover	1824
Macalister, Alexander, of Loup and Torrisdale	1840
Macalister, Charles S., of Kennox	1806
Macalister, Major James, of Springbank	1807
Macalister, Keith Macdonald, of Inistrynish	1829
Macalister, Keith, of Glenbarr	1842
Macallan, James, W.S.	1823
Macarthur, Alexander, Banker, Inverary	1845
Macarthur, Major Alexander, H.E.I.C.S.	1840
Macarthur, Duncan, Dunollybeg	1842
Macarthur, Dr. Peter, of Delnies	1819
Macaskill, Donald, of Rhudunan	1840
Macaskill, Donald, Claggan	1841
Macaskill, Hugh, of Tallisker	1830
Macaslin, Alex., Nursery and Seed Merchant, Glasgow	1838
Macbean, Æneas, W.S.	1812

	Admitted
Macbean, Duncan, of Tomatin, Merchant, Glasgow	1828
Macbean, Lieut.-Colonel James, late 78th Regiment	1806
Macbride, James, Merchant, Greenock	1844
Machray, Isaac, Torry Farm, near Aberdeen	1841
M'Call, Henry, younger of Daldowie	1846
M'Call, James, of Daldowie	1844
MacCall, Thomas, Glasgow	1838
MacCallum, George Kellie, Charlton House	1842
MacCallum, John, Plewlands	1843
MacCheyne, Adam, W.S.	1819
MacClelland, George, W.S.	1838
MacColl, Donald, Appin House	1843
MacConnell, Archibald, Merchant, Glasgow	1845
MacConnell, John, Penrith	1842
Maconochie, Alexander, of Meadowbank, Treasurer of the Society	1800
Maconochie, Allan, younger of Meadowbank	1842
MacCorquodale, Hugh, St. John Street, Edinburgh	1803
MacCulloch, John, of Barholm	1810
Macdiarmid, John, Dumfries	1827
Macdonald, Alexander, of Lochshiel	1824
Macdonald, Major-General Alex., Royal Horse Artillery	1810
Macdonald, Dr. Alexander, Royal Artillery, Prince Edward's Island	1838
Macdonald, Alexander, Beauly, Factor for Lord Lovat	1841
Macdonald, Alaster M'Ian, younger of Dalchoisnie	1841
Macdonald, Alexander, Broadford, Skye	1840
Macdonald, Captain Angus, of Milltoun	1798
Macdonald, Angus, of Glenaladale	1827
Macdonald, Archibald, Islay	1838
Macdonald, Major Donald, of Ardmore	1822
Macdonald, Captain Donald, of Isauld, Royal Engineers	1817
Macdonald, Donald, of Craignuie	1829
Macdonald, Donald, Lochinver	1834
Macdonald, Hugh P., of Mugstad	1830
Macdonald, James Thomas, of Balranald	1832
Macdonald, Major-General John, of Dalchoisnie	1819
Macdonald, John, Procurator-Fiscal, Dunfermline	1836
Macdonald, John Robertson, Rodil, Harris	1841
Macdonald, Matthew Norman, W.S.	1818
Macdonald, Ranald, of Bornish	1806
Macdonald, Reginald George, of Clanranald	1807
Macdonald, Lieut.-Col. Robert, of Inchkenneth, C.B.	1814
Macdonald, Roderick C., of Castle Teirim, Paymaster, 30th Regiment	1839
Macdonald, Thomas, Fort-William	1827

	Admitted
Macdonald, Lieut.-Colonel William, of Calley	1813
Macdonald, William, M.D., Edinburgh	1818
Macdonald, William, Abbotsford Place, Glasgow	1844
Macdonald, William Bell, of Rammerscales	1841
Macdonald, William Farquharson, of St. Martins and Garth	1844
Macdonell, Alexander, W.S., and Sheriff-Substitute of Wigtonshire	1832
Macdonell, Æneas Ranaldson, of Glengarry	1839
Macdonell, Æneas Ronald, of Morar	1846
Macdoual, Lieut.-Colonel, C.B., Stranraer	1824
Macdouall, Lieut.-Colonel James, of Logan, 2d Life Guards	1838
Macdougal, Colin, of Lunga	1808
Macdougal, Dugald, of Gallanach	1814
Macdougal, Major Patrick, of Soroba	1800
Macdougal, Captain James Patrick, H.E.I.C.S.	1838
Macdougall, Allan, W.S.	1829
Macdougall, John, of Macdougall, Captain. R.N.	1821
Macdowall, Colonel Day Hort, of Garthland	1846
Macdowall, Henry, Carruth, Renfrewshire	1845
Macduff, Alexander, of Bonhard, W.S.	1843
Macduff, Captain Alexander, Factor for the Duke of Atholl	1839
Maceachern, Captain Colin, of Oatfield	1825
Macewan, James, of Tar of Ruskie	1834
M'Ewan, Alexander, of Sunderland	1846
M'Ewan, John, Merchant, Inverness	1839
Macfarlane, Alexander, of Thornhill	1825
Macfarlane, John, of Muckroy	1821
Macfarlane, John Fletcher, Surgeon, Edinburgh	1823
Macfarlan, Rev. Dr. Patrick, Greenock	1839
Macfarlane, Thomas, Clachan	1829
Macfarlane, Henry Butter, F.R.C.S.E., Perth	1846
Macfarlan, William, of Bencloich	1832
Macfie, John, Regent Terrace, Edinburgh	1823
Macfie, William, yr. of Langhouse, Merchant, Greenock	1826
Macgillivray, John L., of Dunmaglass	1838
Macgregor, Alexander, London	1837
Macgregor, Alexander, Jun., Glasgow	1823
Macgregor, Lieut.-Col. Hugh, late 91st Regiment	1814
Macgregor, The Rev. Gregor, Minister of Lismore and Appin	1840
Macgregor, Robert, Tacksman of Delavorar	1839
Macgregor, James, Fort-William	1833
Macgregor, John, of Glengyle	1832
Macgregor, Lieut.-General Murray, H.E.I.C.S.	1801
Macilwraith, James, of Auchenflower	1835
Mackinlay, David, Oswald Bank, Partick	1844

	Admitted
Macinnes, James, S S.C.	1812
Macinnes, John, at Dandaleith	1822
Macinroy, James Patrick, of Lude	1831
Macintyre, John, Cleugh Farm, Oban	1844
Macinroy, William, of the Burn	1827
Mackintosh, Alexander, of Mackintosh	1833
Mackintosh, Colonel Alexander, of Farr	1839
Mackintosh, Angus, of Holm	1844
Mackintosh, Æneas, yr. of Mackintosh	1839
Mackintosh, Æneas W., of Raigmore	1844
Mackintosh, Eneas, of Balnespick	1846
Mackintosh, George, of Campsie and Dunchattan	1838
Mackintosh, George Gordon, of Balnespick	1846
Mackintosh, George, of Geddes and Hilton	1832
Macintosh, William, of Millbank	1813
Macintosh, Donald, Edinburgh	1816
Macivor, John, of Ardmarnock	1827
Mackay, Charles, jeweller, North Bridge, Edinburgh	1839
Mackay, George, of Bighouse	1846
Mackay, James, Goldsmith, Edinburgh, the Society's Goldsmith and Jeweller	1804
Mackay, John, Banker, Inverness	1837
Mackay, Thomas George, W.S., Factor on the Estate of Moncrieffe	1837
Mackellar, Rev. Dr. Angus, Edinburgh	1818
Mackellar, Duncan, Inverleith Row, Edinburgh	1839
Mackenzie, Alexander, Writer, Perth	1829
Mackenzie, Alexander, yr. of Muirton	1846
Mackenzie, Daniel, Junior, Merchant, Glasgow	1844
Mackenzie, George Ross, of Aldie	1819
Mackenzie, James, W.S.	1845
Mackenzie, James William, Banff	1825
Mackenzie, John, of Glack	1835
Mackenzie, John, Ness House, Inverness	1809
Mackenzie, John, Writer, Edinburgh	1813
Mackenzie, John, Writer, Tain	1835
Mackenzie, John Hay, of Cromertie	1822
Mackenzie, John Whiteford, W.S.	1821
Mackenzie, Keith William Stewart, of Seaforth	1846
Mackenzie, Kenneth Francis, Edinburgh	1811
Mackenzie, Kenneth John, yr. of Applecross, Advocate	1845
Mackenzie, George, Dingwall	1830
Mackenzie, Murdo, Stornoway	1839
Mackenzie, Murdo, at Dundonnell	1799
Mackenzie, Richard, of Dolphinton, Deputy-Keeper of the Signet	1809

	Admitted
Mackenzie, Robert Duncanson, of Culdarvan	1838
Mackenzie, Sutherland, Charlotte Square, Edinburgh	1808
Mackenzie, Captain, 92d Highlanders	1845
Mackenzie, Thomas, of Ord	1846
Mackenzie, Dr. William, of Culbo, Edinburgh	1810
Mackenzie, Thomas, of Applecross, M.P.	1816
Mackenzie, William, of Muirton	1803
Mackenzie, William Forbes, of Portmore, M.P.	1831
Mackerrel, Henry, of Hillhouse	1837
Mackie, James, yr. of Bargaly	1845
Mackie, John, of Bargaly, Convener of the Stewartry of Kirkcudbright	1844
Mackilligin, William, of Relugas	1837
Macinlay, John, Rothesay	1818
Mackinnon, Alexander Kenneth, of Corry	1827
Mackinnon, Dr. Farquhar, of Kyle	1819
Mackinnon, Rev. John, Minister of Slate	1815
Mackinnon, Neil, of Demerara	1829
Mackinnon, William Alexander, of Mackinnon, M.P.	1811
Mackintosh, Charles, of Aberarder	1831
Mackintosh, John, Manufacturer, Inverness	1839
M'Knight, Robert, of Barlochan	1840
Maclachan, Colin, Laudle	1836
Maclachan, Dugald, Fort-William	1832
Maclachan, Dugald, of Killimore	1838
Maclachan, Eun, Liddesdale	1836
Maclachan, George, W.S.	1843
Maclachan, Peter, Bank Agent, Pulteneytown	1839
Maclachan, Robert, of Maclachan	1817
Maclaine, John, of Killundine	1822
Maclaine, Hugh, yr. of Killundine	1847
Maclaine, Murdoch, of Lochbuy	1835
Maclaren, Major, Portobello, late Madras Army	1844
Maclaren, Charles, Edinburgh	1833
Maclaren, Donald, of Dullatur, Callander	1832
Maclaren, Duncan, Cambusserricht	1834
Maclaren, James, Gavel House, Kilsyth	1832
Maclaren, John, of Balmeannoch	1839
Maclean, Colonel Alexander, of Ardgower	1793
Maclean, Alexander, of Carsaig	1835
Maclean, Colonel Allan Thomas, late 13th Light Dragoons	1835
Maclean, Archibald D., Navy Pay-Office, London	1837
Maclean, Colin, of Laggan, Islay	1838
Maclean, Donald, of Boreray	1822
Maclean, Donald, of Kinloch, W.S.	1793
Maclean, Hugh, of Coll	1819

	Admitted
Maclean, Hugh, Brighton	1827
Maclean, Dr. Lachlan, Tobermory	1823
Maclean, Neil, Land-Surveyor, Inverness	1837
Maclean, James, Braidwood, Pennicuik	1841
Maclean, Patrick, of Hawkhill	1845
Maclean, William, of Plantation, Glasgow	1838
Maclean, Captain William, R N., Ardgower	1840
Macleay, Alexander D , Bilbster, Wick	1846
Macleay, Kenneth, of Newmore	1839
Macleish, Adam, Merchant, Greenock	1831
Maclelland, Thomas, Banker, Ayr	1836
Macleod, Alexander, Surgeon, Uist	1829
Macleod, Alexander, of Canada	1811
Macleod, Alexander Norman, late of Harris	1817
Macleod, Donald, at Gledfield	1830
Macleod, Norman, of Macleod	1839
Macleod, Mrs., Senior of Macleod	1816
Macleod, Norman, of Dalvey	1839
Macleod, Martin, of Drynoch	1831
Macleod, Roderick, of Cadboll	1807
Macleod, Colonel W., H.E.I.C.S.	1817
Maclellan, John, Merchant, Greenock	1831
Maclennan, Duncan, Solicitor, Inverness	1840
Maclennan, John, of Lyndale	1840
Macmickan, James Clerk, of Corbieton	1841
Macmillan, Donald, of Lephenstrath	1825
Macmillan, Captain Iver, H.E.I.C S.	1798
Macmillan, James, of Lawloch	1834
Macmillan, Peter L , of Barwhinnock	1844
Macnab, Archibald, of Macnab	1806
Macnab, Gilbert, Sheriff-clerk Depute, Ayr	1836
Macnabb, James Monro, late of Arthurstone	1837
Macnair, James, of Balvie	1838
Macneale, George, of Ugadale	1825
Macneill, Alexander, of Colonsay	1835
Macneill, Archibald, Great King Street, Edinburgh	1846
Macneill, Dugald, Saddel House	1847
Macneill, Duncan, Dean of the Faculty of Advocates, M.P.	1833
Macneill, John, of Ardnacross	1847
Macneill, Major-General Roderick, Barra	1817
Macneel, Alexander, Collector of Customs, Stranraer	1829
Macneill, Alexander, Advocate	1835
Macneill, Malcolm, Lossit, Islay	1835
M'Neill, Malcolm Macmillan, younger of Carskey	1839
Macnicol, John, Factor for the Earl of Airlie	1831
Macnicol, Nicol, Lieut., half-pay 27th Regiment	1836

	Admitted
Macombie, James Boyn, of Gillybrands, Advocate, Aberdeen	1840
Macombie, William, of Linturk and Easter Skene	1840
Macombie, William, Tillyfour, Aberdeen	1847
Macpherson, Lieut. Alexander, Ruthven, Kingussie	1839
Macpherson, Alexander, M.D., Garbity	1841
Macpherson, Allen, Harley Place, New Road, London	1822
Macpherson, Captain, Æneas, Nuidmore, Kingussie	1839
Macpherson, Col. D., Strathmashie, Kingussie	1839
Macpherson, Major-General Duncan, H.E.I C.S.	1825
Macpherson, Lieut.-Colonel Duncan, Adersier	1840
Macpherson, Captain Duncan, Collector of Customs at Inverness	1839
Macpherson, Duncan, Pitmain, Kingussie	1841
Macpherson, Ewan, of Cluny Macpherson	1827
Macpherson, George Gordon, Surgeon, H.E.I.C.S.	1841
Macpherson, Hugh, of Eigg, M.D., one of the Professors of King's College, Aberdeen	1828
Macpherson, Kenneth, late Member of the Hon. House of Assembly, Jamaica	1826
Macpherson, Captain Lachlan, Ballidmore, Kingussie	1839
Macpherson, William, of Blairgowrie	1822
Macqueen, John, Auchenhay	1841
Macqueen, Robert, of Braxfield	1842
Macqueen, Captain Simon, Corrybrough	1820
Macrae, Alexander, Askernish	1832
Macrae, Archibald, M.D., Bruiach, Inverness-shire	1839
Macrae, Colin, of Demerara	1823
Macrae, Rev. Finlay, Minister of North Uist	1841
Macredie, Patrick Boyle Mure, of Perceton	1830
Macritchie, Charles Elder, Edinburgh	1831
Macritchie, John, Whitburgh, Ford	1846
Macritchie, Thomas Elder, of Craigton, W.S.	1831
Mactaggart, Captain J. O., H E.I.C.N.S.	1835
Mactavish, Alexander, Solicitor, Inverness	1839
Mactavish, Duncan, Garthbeg	1840
Mactier, Anthony, of Durris	1834
Mactuik, Robert, of Hastingshall	1826
Macvicar, John, of Ardarroch	1842
Macvicar, Rev. J. G., Ceylon	1828
Macwilliam, George, Land Surveyer and Farmer at Sheriffston	1841
Madden, Henry R., M.D., Vienna	1839
Main, Alexander James, Whitehill	1847
Maitland, Thomas, of Dundrennan, M. P., Solicitor-General for Scotland	1844

	Admitted
Makgill, George, of Kemback	1841
Makins, Edward, Auchincraw Mains, Berwickshire	1841
Malcolm, Neill, of Poltalloch	1830
Malcolm, William E., of Burnfoot	1840
Manford, Robert Alexander, Surgeon, Inverness	1839
Mansfield, Thomas, Accountant, Edinburgh	1827
Marshall, Claud, Sheriff-substitute of Renfrewshire	1819
Marshall, Henry, Dep. Inspector-General of Hospitals	1833
Marshall, James, Jeweller, Edinburgh	1833
Marshall, John, Advocate, of Curriehill	1822
Marshall, John, of Alnham, Northumberland, and Achinduich, Sutherland	1847
Marshall, Walter, Jeweller, Edinburgh	1839
Marshall, Captain William, Rothesay	1845
Marshall, William, Goldsmith, Edinburgh	1843
Martin, George, Civil-Engineer, Glasgow	1839
Martin, William, Factor for Neill Malcolm, Esq., of Poltalloch	1844
Martin, William, Secretary Renfrewshire Agricultural Society, Paisley	1846
Matheson, Alexander, of Ardross	1846
Matheson, James, of Achany, M.P.	1843
Matheson, Lieut.-Colonel Thomas	1847
Mathieson, Gordon Clunes, Tacksman of Culgower, Sutherlandshire	1839
Maule, William, Nelson Street, Edinburgh	1830
Maxton, John, Wine Merchant, Leith	1835
Maxwell, Alexander Harley, of Portrack	1834
Maxwell, Francis, of Breoch	1841
Maxwell, Francis, Writer, Glasgow	1844
Maxwell, Henry, Merchant, Leith	1830
Maxwell, Henry Constable, of Milnehead	1838
Maxwell, John, Westwater	1838
Maxwell, John Argyll, late at Aros	1834
Maxwell, John Hall, younger of Dargavel, Secretary of the Society	1838
Maxwell, Lieut.-Col., of Orchardtown and Gretna	1825
Maxwell, Marmaduke, of Terregles	1830
Maxwell, Wellwood, of the Grove	1838
Maxwell, Wellwood, of Munches	1839
Maxwell, William, younger of Cardoness	1841
Maxwell, William, of Carruchan, Chamberlain to the Duke of Buccleuch and Queensberry	1837
Maxwell, William Constable, of Nithsdale and Evringham	1830
May, George, Civil Engineer, Superintendent of the Caledonian Canal	1839

	Admitted
Mayne, Robert, Melville Street, Edinburgh	1838
Meason, Magnus Gilbert Laing, of Ballinshoe	1836
Mechi, John Joseph, of Tiptree Hall, Essex, and Leadenhall Street, London	1845
Meek, George, of Campfield	1814
Megget, Thomas, W.S.	1811
Meiklejohn, Rev. Robert, Minister of Strathdon	1840
Meiklam, James, of Cairnbroe	1831
Mein, Robert, Sunlawshill	1838
Meldrum, Alexander, of Easter Kincaple	1841
Melrose, Andrew, Merchant, Pendreich	1815
Melville, John White, of Mount Melville	1819
Menteath, James Steuart, younger of Closeburn Hall	1837
Menzies, Major Archibald, late of the 42d Royal Highland Regiment	1817
Menzies, Fletcher Norton, Castle Menzies	1841
Menzies, George Cumming, of Knockintober	1837
Menzies, James, of Pitnacree	1834
Menzies, John, of Chesthill	1821
Menzies, Ranald, of Culdares	1842
Menzies, Robert, Land-surveyor, Dunkeld	1829
Mercer, George, of Gorthy	1822
Mercer, Dr. James, F.R.C.S.E., Lecturer on Anatomy, &c., Edinburgh	1844
Merricks, James, Gunpowder Manufacturer, Roslin	1841
Merry, James, Glasgow	1838
Middleton, Charles Stuart, Merchant, Liverpool	1840
Mill, James, Surgeon, Wick, Joint-Tacksman of Luggate, Haddingtonshire	1839
Mill, John, Merchant, Edinburgh	1814
Millar, Andrew, Merchant, Edinburgh	1827
Millar, William, Writer, Wick	1839
Miller, Captain Alexander Penrose, 92d Highlanders	1843
Miller, George, of Frankfield	1814
Miller, O. G., Writer, Dundee	1843
Miln, James, of Woodhill	1837
Milne, Alexander, of Gartferry	1844
Milne, David, of Milnegraden, Advocate	1835
Milne, Nicol, of Faldenside	1841
Mitchell, Alexander, Civil Engineer, Perth	1838
Mitchell, Colonel James, late of the 92d Regiment	1821
Mitchell, John, Jun., Merchant, Leith	1832
Mitchell, John, Inverscaddle, Ardgour	1843
Mitchell, Joseph, Civil Engineer, Inverness, and Superintendent of the Parliamentary Roads in Scotland	1836
Mitchell, Patrick, Enzean, Monymusk	1831

	Admitted
Mitchelson, Arch. Hepburne, late of Middleton	1832
Moir, Benjamin, Merchant, Aberdeen	1840
Moir, John Macarthur, of Hillfoot and Milton	1834
Moncrieff, Alexander, W.S., Perth	1842
Moncrieff, Robert Scott, of Fossaway	1831
Moncrieff, Robert Hope, Perth	1807
Monro, Dr. Alexander, of Craiglockhart	1807
Monro, Alexander, yr. of Craiglockhart, Rifle Brigade	1835
Monro, Alexander Binning, of Auchenbowie	1833
Monro, Donald, of Latheron, Caithness	1839
Monteath, James, of Stonebyres	1838
Monteath, James, of Monkridden Mains	1845
Monteath, John, yr. of Monkridden Mains	1845
Monteith, Brydon, Edinburgh	1846
Monteith, Henry, of Carstairs	1808
Monteith, Robert, yr. of Carstairs	1837
Montgomerie, Alexander, Captain R.N.	1834
Montgomerie, John, of Newton	1846
Montgomerie, Major H. A., of Arndean	1841
Montgomerie, William, of Belmont	1836
Montgomery, Robert Stanhope, Atholl Crescent	1829
Monnypenny, David, of Pitmilly	1804
Moore, James Carrick, of Corsewall	1829
Moore, John Carrick, yr. of Corsewall	1839
More, John Shank, Advocate, Professor of Scots Law in the University of Edinburgh	1816
Moreland, Charles, Banker, Stranraer	1827
Morgan, James, Solicitor in the Supreme Courts	1841
Morison, Alexander, of Bognie and Mountblairy	1840
Morison, Major-General William, C.B., M.P.	1842
Morris, William Pollok, of Craig	1833
Morrieson, Robert, H.E.I.C.S., Edinburgh	1833
Morrison, A. G., Salachar, Ardgour	1843
Morrison, Alexander, Writer, Glasgow	1838
Morton, Robert, Edinburgh	1812
Morton, Hugh, Engineer, Leith Walk	1835
Morton, Hugh, Writer, Glasgow	1844
Mouat, William Cameron, of Garth	1838
Moubray, John Marshall, of Hartwood, W.S.	1843
Mudie, John, yr. of Pitmuies, Advocate	1840
Muir, Alexander, of Loirston	1847
Muir, Andrew, Merchant, Greenock	1826
Muir, James, Merchant, Greenock	1827
Muir, John, of Gartferry	1843
Muir, Malcolm, Timber-merchant, Glasgow	1838
Muirhead, Claud, Publisher of the Edinburgh Advertiser	1820

	Admitted
Muirhead, James, Jeweller, Glasgow	1844
Munro, Captain Hugh, Coul Cottage	1799
Munro, Hugh Andrew Johnston, of Novar	1832
Munro, Alexander, Princes Street, Edinburgh	1810
Munro, Thomas M., H.E.I.C.S., Wooden	1843
Murdoch, John Burn, of Gartincaber	1820
Murdoch, John, Factor for Major-General Hunter Blair, of Dunskey	1836
Murdoch, Peter	1839
Mure, James O. Lockhart, of Livingstone	1828
Mure, Colonel William, of Caldwell, M.P., Vice Lieutenant of Renfrewshire	1840
Mure, William, Factor to the Earl of Selkirk	1841
Murray, Andrew, yr. of Conland	1846
Murray, Anthony, of Dollorie, W.S.	1828
Murray, James, of the Monkland Iron-Works	1828
Murray, James, of Craigend	1840
Murray, James, Garnkirk, Lanarkshire	1844
Murray, James Thomas, W.S.	1840
Murray, John, Ainslie Place, Edinburgh	1837
Murray, John Dalrymple, of Murraythwaite	1825
Murray, John, Meikleourhouse, Blairgowrie	1840
Murray, John Nisbet, yr. of Philiphaugh	1846
Murray, John, of Murrayshall, Advocate	1842
Murray, Jack W., Captain R.N.	1843
Murray, Joseph, of Ayton	1820
Murray, Patrick, of Simprim	1794
Murray, Captain Samuel Hood, 67th Regiment, Plymouth	1834
Murray, William Home, of Geanies, Advocate	1846
Murray, William, of Polmaise	1806
Murray, William, Athol Place, Glasgow	1827
Murray, William, of Henderland	1826
Mutrie, David, Merchant, Glasgow	1804
Mylne, William, Bolton, Haddington	1841

N

NORTHUMBERLAND, His Grace Hugh, Duke of, K.G.	1842
NORTHESK, Right Hon. William, Earl of	1843
NAPIER, Right Hon. Francis, Lord	1843
NAPIER, Sir William Milliken, of Milliken, Bart.	1820
NASMYTH, Sir John Murray, of Posso, Baronet	1838
NICHOLSON, Sir Arthur, of Lochend, Bart.	1812
Nairn, David, of Drumkilbo and Drumfin	1826
Nairne, James Mellis Drummond, of Dunsinane	1821
Nairne, James, late of Claremont	1829

	Admitted
Napier, George, Advocate, Sheriff of Peebles-shire	1810
Napier, Robert, of Lancefield	1844
Napier, William, late Factor for Gartmore	1843
Napier, William, late of Blackstone	1815
Nasmyth, Robert, George Street, Edinburgh	1839
Neaves, Charles, Sheriff of Orkney and Shetland	1846
Neil, Lieut.-Colonel William Smith, of Barnweill and Swinridgemuir	1824
Neill, Patrick, LL.D., Secretary Caledonian Horticultural Society	1808
Neilson, Robert, of Hilton	1831
Newall, James, Banker, Newton Stewart	1845
Newall, John, Cassencairie, Creetown	1845
Newbigging, John Stewart, W.S.	1836
Newton, James, Merchant, Leith	1838
Newton, James, of Castlandhill, W.S.	1846
Newton, Robert Pillans, Factor for Lord Frederick Gordon Hallyburton	1837
Nicholson, Major Allan Macdonald, of Ardmore	1819
Nicol, John Inglis, M.D., Inverness	1839
Nicol, James, Milden, Advocate, Aberdeen	1840
Nicol, James, Leithen Bank, Howe Street, Edinburgh	1846
Nicoll, Alexander, Edinburgh	1844
Nielson, Andrew, Bank of Scotland, Glasgow	1843
Nisbett, John More, of Cairnhill	1847
Noble, John, Gloucester Place, London	1838
Noble, William, Fleet Street, London	1838

O

Ogilvy, The Honourable William, of Airlie	1823
Ogilvy, The Honourable Donald, of Clova	1824
Ogilvy, Sir John, of Inverquharity, Bart.	1824
Orde, Sir John Poullet, of Kilmory, Bart.	1830
Ogden, John Biss, Berryhill	1841
Ogilvie, David William Balfour, of Tannadice	1842
Ogilvie, Captain William, R.N.	1820
Ogilvie, William, of Chesters	1809
Ogilvy, John, of Inshewan	1836
Ogilvy, Peter Wedderburn, of Ruthven	1826
Ogilvy, Thomas, yr. of Ruthven, 2d Life Guards	1844
Ogilvy, Thomas, of Corrimony and Lakefield	1838
Ogston, Alexander, of Ardo	1840
Oliphant, Charles, W.S.	1813
Oliphant, Laurence, of Condie	1828
Oliphant, James, of Gask	1828
Oliphant, Robert, younger of Rossie	1840

		Admitted
	Oliver, Robert Stephen, Merchant, Edinburgh	1842
	Ord, John, Younger of Muirhouselaw	1841
	Orr, Andrew, of Glenfield	1844
	Orr, Charles James Fox, of Thornly Park, W.S.	1816
	Orr, Patrick, W.S.	1825
	Oswald, Alexander, M.P., for Ayrshire	1845
	Oswald, James, of Auchincruive, M.P.	1829
	Oswald, Lieut.-Colonel Robert, Dunnikier	1824

P

	POLWARTH, The Right Hon. Henry Francis H., Lord	1829
†	PANMURE, The Right Hon. William, Lord	1805
	PRINGLE, Sir John, of Stitchell, Bart.	1810
	PARISH, Sir Woodbine, late Chairman of the Board of Excise	1819
	POLLOK, Sir Hew Crawford, of Pollok, Bart.	1846
	Pagan, William, Cupar-Fife	1845
	Parkes, Samuel, London	1817
	Paterson, Alexander, Wine Merchant, Leith	1840
	Paterson, Campbell, Banker, Oban	1844
	Paterson, George, of Castle Huntly	1841
	Paterson, John, Factor to the Duke of Hamilton in Arran	1826
	Paterson, John, Borlum	1832
	Paterson, Henry, Manager of the North of Scotland Bank	1839
	Paterson, Robert, of Brocklehirst	1835
	Paterson, John, Killconan	1847
	Patterson, William, of Cunnoquhie	1847
	Patison, John, W.S.	1806
	Paton, John, of Crailing	1833
	Paton, John, of Grandholm	1841
	Patrick, Captain James, of Drumbowie	1836
	Patrick, William, of Roughwood, W.S.	1805
	Patton, George, of Cairnies, Advocate	1843
	Patton, James Murray, of Glenalmond	1830
	Paul, Henry, Edinburgh	1830
	Paul, William, Accountant, Edinburgh	1829
	Paul, Rev. John, one of the Ministers of St. Cuthbert's, Edinburgh	1839
	Pearson, Alexander, W.S.	1819
	Peddie, William, Writer, Perth	1828
	Pender, Thomas, Comptroller-General of Stamps and Taxes	1839
	Pennycuick, Major John, of Soilarie	1823
	Penny, William, Advocate	1844
	Peter, John, Dundee	1828
	Philip, Robert, Merchant, Leith	1844

	Admitted
Philip, John, Distiller, Leith	1828
Pillans, James, Regent Terrace	1799
Piper, Edward, Edinburgh	1833
Pitcairn, John, of Pitcairns	1815
Pitcairn, John, Junior, of Pratis	1841
Playfair, William Henry, Architect, Edinburgh	1824
Plummer, Charles, of Sunderlandhall	1842
Pollexfen, James R., of Cairston, W.S.	1841
Pollock, Arthur, Merchant, Grangemouth	1815
Pollock, John, Merchant, Glasgow	1838
Pollok, Allan, yr. of Faside	1844
Popham, Strachan Irvine, Ardchattan Priory, Bonaw	1843
Pringle, Alexander, of Whytbank	1821
Pringle, Major David, of Carriber	1842
Pringle, Captain James, R.N., of Torwoodlee	1820
Proctor, William D., Glammis, Factor on the Strathmore Estate	1829
Purves, James, Thurdistoft, Caithness	1839
Purves, John, younger of Kinaldie	1844

Q

†Queensberry, The Most Noble John, Marquis of	1825

R

*Richmond and Lennox, His Grace Charles, Duke of, K.G.	1836
†Roxburghe, His Grace James Henry Robert, Duke of, K.T.	1837
†Rosebery, The Right Honourable Archibald John, Earl of, K.T.	1806
Rosslyn, The Right Honourable James Alexander, Earl of	1835
Ranfurly, The Right Honourable Thomas, Earl of	1838
Reidhaven, The Right Honourable John Charles, Viscount	1842
Ruthven, The Right Honourable James, Lord	1810
Rollo, The Right Honourable William, Lord	1838
Rutherfurd, Right Honourable Andrew, of Lauriston, M.P., Lord Advocate for Scotland	1845
Robertson, The Honourable Lord	1816
Ramsay, Sir James, of Banff, Bart.	1823
Riddell, Sir James Milles, of Adnamurchan and Sunart, Bart.	1808
Ramsay, Sir Alexander, of Balmain, Bart.	1813
Radcliffe, Sir Joseph, of Millsbridge, Bart., Yorkshire	1820
Richardson, Sir John Stewart, of Pitfour, Bart.	1823
Russell, Major-General Sir James, of Ashiesteil, K.C.B.	1823
Rose, Major-General Sir John, of Holm, K.C.B.	1831
Railton, Edward, Oakfield, Glasgow	1832

	Admitted
Rainy, George, of Rasay	1816
Rait, D. C., Goldsmith, Glasgow	1838
Ralston, Adam, Kilchiren	1841
Ralston, Alexander, Dunduff	1841
Ralston, Robert William, younger of Glenellrig	1840
Ramsay, Alexander, of Demeiara	1806
Ramsay, Captain Thomas, Balmain	1828
Ramsay, William Ramsay, of Barnton	1831
Ramsay, Robert Balfour Wardlaw, of Whitehill	1841
Ramsay, Professor William, Glasgow	1844
Ramsay, William Burnett, of Banchory Lodge	1841
Ranken, Bryce Macmurdo, Procurator-Fiscal of Oikney	1841
Ranken, George, Drumley, Ayrshire	1839
Ranken, James, of Glenlogan	1845
Ranken, Thomas, S.S.C.	1838
Ranken, Patrick, of Mavisbank	1844
Ranken, William, M.D., Roddinghead	1836
Rannie, Thomas, Birdsbank	1842
Rashleigh, William, of Monabilly, M.P., Cornwall	1837
Rathbone, Basil, of Woodcroft, Lancashire	1846
Rattray, Robert Clerk, of Craighall Rattray	1826
Rattray, Thomas, younger of Brewlands	1834
Reid, Charles G., W.S.	1844
Reid, Dr. David Boswell, London	1833
Reid, David, Ellanreach, Inverness	1845
Reid, Ellerington, Kilcolmkill	1847
Reid, Gabriel, Kilcolmkill	1820
Reid, John, of Leithfield	1841
Reid, John, of Annfield	1844
Reid, Robert, Sider House, Sutherland	1847
Rennie, Archibald Hill, of Ballilieak	1839
Rennie, Robert Walker, Inchira, Factor on the Estate of Pitfour	1827
Rennie, William, Banker, Maybole	1836
Renton, James, of Greystonelees	1841
Renton, John Campbell, of Lamberton	1839
Rhind, Josiah, Provost of Wick	1839
Rhind, Macduff, Advocate	1843
Richardson, James, Wine Merchant, Edinburgh	1833
Richardson, John, W.S.	1842
Richardson, Ralph, Merchant, Edinburgh	1828
Richardson, Robert, Merchant, Edinburgh	1837
Richardson, William, Banker, Lockerbie	1813
Richardson, William, Seed Merchant, Edinburgh	1843
Rickman, Thomas, Architect, Birmingham	1831
Riddel, Campbell D., Advocate	1810

	Admitted
Riddell, Charles, of Muselee	1831
Riddell, John, Advocate	1817
Riddell, Thomas Milles, younger of Ardnamurchan and Sunart, Lieutenant 7th Dragoon Guards	1845
Ritchie, Robert, Engineer, Edinburgh	1833
Ritchie, Thomas, Bowhouse Farm	1838
Roberton, James, Ladyrig	1841
Robertson, Alexander, W.S.	1825
Robertson, Alexander, Woodside	1842
Robertson, Andrew, Surgeon, Indego	1832
Robertson, Charles, Buttergask	1836
Roberston, Charles Gordon, Advocate, Sheriff-Substitute of Kincardine	1842
Robertson, David, of Ladykirk	1842
Robertson, David, Aberdeen	1847
Robertson, Captain George A., H.E.I.C.S.	1817
Robertson, George, one of the Deputy-Keepers of the General Records of Scotland	1819
Robertson, George Duncan, of Strowan	1839
Robertson, Henry, of Borland	1832
Robertson, James, Factor for the Duke of Argyll	1836
Robertson, James Stewart, of Edradynate	1811
Robertson, James Saunders, W.S.	1816
Robertson, James Walker, Captain, R.N.	1823
Robertson, Captain John, Edinburgh	1825
Robertson, Laurence, Cashier for the Royal Bank, Glasgow	1828
Robertson, Robert, of Auchleeks	1828
Robertson, William, of Kinlochmoidart	1826
Robertson, William, W.S.	1834
Robertson, Alexander Inglis, yr. of Aultnaskiach	1839
Robertson, Arthur John, of Inches	1840
Robertson, Robert, yr. of Auchleeks	1845
Robertson, Stewart, yr. of Derculich	1843
Robertson, William, of Lauchope	1844
Robson, Charles, Lurdenlaw	1841
Rodger, Robert, Merchant, Glasgow	1838
Rogers, George, Kilconquhar Mains	1842
Rolland, Adam, of Gask and Airds	1837
Rose, James, W.S.	1839
Ross, Alexander, Inverleith Row, Edinburgh	1844
Ross, J. B., yr. of Strathgarve	1839
Ross, Lieut.-Colonel James Kerr, of Lawrence Park	1839
Ross, Lieut.-Colonel Hugh, of Tyndrish	1844
Ross, Hugh, Tacksman of Humberston	1839
Ross, George Clerk, of Culgruff	1840

	Admitted
Ross, John, Berbice Cottage, Inverness	1839
Ross, John, of Arnage	1843
Ross, George, of Pitcalnie	1839
Ross, Colonel John Gray, of Strathgarve	1836
Ross, Richard Louthian, of Staffold	1804
Rotch, Thomas Dickason, of Drumlanford	1845
Rowand, Alexander, yr. of Linthouse	1844
Rowand, Michael, of Linthouse, Banker, Glasgow	1838
Roy, Frederick Lewis, of Nenthorn	1837
Roy, James, jun. Nursery and Seedsman, Aberdeen	1840
Roy, John James, Avochie	1825
Roy, Robert, W.S.	1822
Russell, Alexander James, W.S.	1846
Russell, Francis Whitworth, H.E.I.C.S.	1835
Russell, Henry, Merchant, Dunfermline	1836
Russell, James, of Aden	1834
Russell, James, of Blackbraes	1834
Russell, James L., M.D., Thornhill, Secretary Nithsdale Agricultural Society	1847
Russell, John, one of the Principal Clerks of Session	1806
Russell, Robert, of Dalnair	1834
Rutherford, William Oliver, of Edgertoun and Dinlabyre	1825

S

*Sutherland, His Grace George Granville, Duke of, K.G.	1813
Sutherland, Her Grace Harriet, Duchess of	1834
†Selkirk, The Right Honourable Dunbar James, Earl of	1830
Stair, The Right Honourable John, Earl of, K.T.	1817
†Seafield, The Right Honourable Francis William, Earl of	1803
†Strathallan, The Right Honourable James, Viscount	1811
†Saltoun, The Right Honourable Alexander George, Lord	1820
Sinclair, The Right Honourable Charles, Lord	1829
Scott, Right Honourable Lord John	1833
Stuart, The Right Honourable Lord James, M.P.	1819
Sylvestre, The Baron de, Member of the Institute, Perpetual Secretary of the Royal and Central Society of Agriculture, Paris, Honorary Member	1836
Stuart, Lieut.-General The Honourable Sir Patrick, G.C.M.G., Governor of Malta	1833
Stuart, The Honourable John	1824
Stuart, The Honourable Charles Francis	1826
Sandilands, The Honourable Robert, of Torphichen	1831
Steuart, Sir Henry M. Seton, of Allanton and Touch, Bart.	1835
Seton, Sir William C., of Pitmedden, Bart.	1834

	Admitted
SINCLAIR, Sir John Gordon, of Stevenston and Murkle, Bart.	1832
SINCLAIR, Sir George, of Ulbster, Bart.	1812
SCOTT, Sir William, of Aucrum, Bart.	1829
STEWART, Sir William Drummond, of Grantully, Bart.	1839
SUTTIE, Sir George Grant, of Balgone and Prestongrange, Bart.	1839
SINCLAIR, Sir John, of Dunbeath, Bart.	1824
Saddler, Thomas, Norton-Mains, Edinburgh	1838
Salmon, Henry, Banker, Falkirk	1834
Salmond, Robert, Banker, Glasgow	1845
Salmond, Duncan, Rothesay	1846
Sandeman, David, of Kirkwood	1831
Sanderson, Captain Archibald, Barjarg House	1844
Sanderson, George, Merchant, Edinburgh	1842
Sandford, Erskine Douglas, Advocate, Steward of the Stewartry of Kirkcudbright	1827
Sandilands, Captain William, of Barneyhill	1838
Sangster, Robert B., Banker, Golspie	1845
Sawers, John, of Loanhead, Procurator-Fiscal, Stirlingshire	1834
Sawers, Simon, of Newhouse, Dunbar	1839
Scarth, James, Banker, Leeds	1828
Scarth, Robert, of Scarth	1843
Scales, Andrew, of the Customs, Leith	1828
Scot, William, of Craigmuie	1838
Scotland, John, Factor to Lord Douglas	1835
Scott, Alexander, of Knockhill, Billholm, Langholm	1839
Scott, Alexander, Kinninghall	1842
Scott, Alexander, Craiglockhart	1844
Scott, Carteret G., of Malleny	1842
Scott, Charles, Merchant, Greenock	1831
Scott, David, H.E.I.C.S.	1823
Scott, Captain George, of Wooden	1844
Scott, Lieutenant-Colonel George, Edinburgh	1821
Scott, Hugh, of Gala, Lieutenant 92d Highlanders	1846
Scott, James Fitzmaurice, of Commieston	1843
Scott, John, of Hawkhill, Merchant, Greenock	1826
Scott, John, of Teviot Bank, W.S.	1842
Scott, Captain Robert, H.E.I.C.N.S., Bellechin, Dunkeld	1841
Scott, Thomas Rennie, Factor to Lord Douglas	1827
Scott, Thomas, of Beechwood	1843
Scott, Thomas M'Millan, younger of Wauchope, W.S.	1843
Seller, Patrick, of Acharn	1818
Shairp, Major Norman, of Houston	1823
Shand, John, W.S.	1844
Shand, Robert, Advocate, Aberdeen	1840

	Admitted
Sharp, James, Drums House, Renfrewshire	1846
Sharp, Thomas, Manufacturer, Paisley	1839
Shawe, R. F., of Brantinghame Thrope, near Hull	1838
Shaw, Charles, Sheriff-Substitute in Skye	1835
Shaw, David, W.S., Ayr	1836
Shaw, Patrick, Advocate	1835
Shearer, James, retired Surveyor, G. P. Office	1800
Shepherd, James, W.S.	1828
Sheriff, Charles, Sheriff-Substitute, Dunfermline	1829
Sherriff, David, Barnyards	1837
Sim, Adam, of Coulter Mains	1836
Sim, William, Tacksman of Drummond	1839
Simson, George, younger of Pitcorthie	1841
Simpson, Alexander, Helmsdale	1821
Simpson, Alexander Horatio	1830
Simpson, Alexander, Teawig, Beauly	1846
Simpson, Robert, of Cobairdy	1839
Simpson, William, of Glenythan, Procurator-Fiscal for Aberdeenshire	1835
Sinclair, Alexander, H.E.I.C.S.	1839
Sinclair, Dugald, Kilchamaig	1826
Sinclair, James, of Forss	1830
Sinclair, John, of Lochaline	1834
Sinclair, John, of Redcastle	1837
Sinclair, John, Inverhagcraig, Tyndrum	1845
Sinclair, Robert, Merchant, Greenock	1826
Sinclair, William James John Alexander, of Freswick	1843
Sitwell, William, Dunmore Park, Stirlingshire	1845
Skelton, George, of Invernettie Lodge	1837
Skene, George, younger of Rubislaw, Advocate	1831
Skene, Patrick George, of Hallyards	1825
Skene, William F., W.S.	1831
Skinner, Captain C. G. Macgregor, Belfast	1823
Skinner, James, at Drumin, Factor to the Duke of Richmond	1827
Skirving, Robert Scot, of Campton	1816
Sligo, John, of Carmyle	1827
Smail, William Archibald, of Overmains	1816
Small, David, Writer, Dundee	1843
Small, Patrick, of Dirnanean	1826
Small, William, Merchant, Dundee	1843
Smith, Alexander, Civil Engineer, Aberdeen	1847
Smith, Alexander, of Glenmillan, Advocate, Aberdeen	1822
Smith, Archibald, younger of Carbeth-Guthrie, Advocate	1838
Smith, Charles Hope Johnstone, Garden Architect, Edinburgh	1836

	Admitted
Smith, David, W.S.	1833
Smith, Donald, Banker, Glasgow	1844
Smith, Eaglesfield Bradshaw, of Blackwood House	1839
Smith, George Moffat, Surgeon, R.N.	1829
Smith, George Campbell, Land-Surveyor, Banff	1837
Smith, George, Distiller, tenant of Minmore and Castleton	1839
Smith, James, of Jordanhill	1823
Smith, James, Agricultural Engineer, London	1821
Smith, James, Architect, Glasgow	1838
Smith, James, of Olrig, Caithness	1839
Smith, James Graham, Craigend	1845
Smith, John, of Craigend	1845
Smith, John, of Crutherland, LL.D.	1838
Smith, John, Factor for Lord Douglas, Harecraig, Dundee	1843
Smith, Robert, Stafford Street, Edinburgh	1839
Smith, Thomas, Banker, London	1798
Smith, Thomas, at Penfillan	1834
Smith, William, of Carbeth-Guthrie	1823
Smyth, Robert Gillespie, of Gibliston	1834
Smythe, Robert, of Methven	1840
Smythe, William, Advocate	1846
Smollett, Alexander, of Bonhill, M.P.	1826
Somerville, Samuel, of Amphorlaw, M.D., Edinburgh	1841
Somerville, Samuel May, of Broadfield	1845
Somerville, James, Merchant, Glasgow	1838
Somerville, Thomas, of Greenfield	1845
Souter, Francis George, Durn House, Banffshire	1840
Spear, Robert, of Culdaes and Burnbrae	1838
Spear, Thomas, of Blackstone	1838
Speid, James, of Forneth	1843
Speirs, Graham, Advocate, Sheriff of Edinburghshire	1836
Speirs, Thomas Dundas, Elderslie	1838
Spens, William, Manager of the Scottish Amicable Assurance Society, Glasgow	1845
Spottiswoode, John, of Spottiswoode	1812
Spottiswoode, James Brodie, of Muiresk	1834
Sprot, James, of Spot	1830
Sprot, John, Rutland Square, Edinburgh	1830
Sprot, Mark, of Garnkirk	1820
Sprot, Mark, of Riddell	1830
Sprot, Thomas, W.S.	1826
Stables, William Alexander, of Park	1836
Staveit, Thomas, of Hosecoat	1827
Steele, William, Advocate	1828
Stein, Charles, of Hattonburn	1837
Stephen, Moses, of Bellahouston, Advocate	1832
Stephens, Henry, Redbrae Cottage, Edinburgh	1826

	Admitted
Stevenson, Alexander, S.S.C.	1813
Stevenson, Alexander, Banker, Langholm	1839
Stevenson, Andrew, late Minister Plenipotentiary from the United States of America, Honorary Member	1839
Stevenson, Duncan, Printer to the University of Edinburgh	1824
Stevenson, Captain Hugh, late Argyleshire Militia	1805
Stevenson, John, Oban	1842
Stevenson, Nathanael, of Braidwood	1838
Stevenson, Robert, Civil-Engineer, Edinburgh	1807
Stevenson, Thomas, Merchant, Leith	1831
Steuart, Andrew, of Auchlunkart	1845
Steuart, Alexander, of Dercullich	1805
Steuart, Archibald Seton, Alloa	1835
Steuart, Claude Scott, Portland Place, London	1843
Steuart, James, W.S.	1842
Steuart, William, of Glenormiston	1833
Stewart, Charles, Solicitor, Inverness	1840
Stewart, Charles, of Ardsheal	1846
Stewart, Charles, of Hillside	1823
Stewart, Charles, Chesthill	1834
Stewart, David, Great Russell Street, Bloomsbury, London	1842
Stewart, Donald, Luskintyre	1817
Stewart, Captain Dugald	1799
Stewart, George, Kirkchrist, Kirkcudbright	1844
Stewart, George Drummond, of Braco Castle	1838
Stewart, Henry, of St. Fort	1837
Stewart, Henry Black, of Balnakieley	1838
Stewart, Captain Houston, of Gart, R.N.	1822
Stewart, James. Tacksman of Deskie and Delmore	1839
Stewart, James, Merchant, Greenock	1825
Stewart, James Hope, of Gilloubie	1838
Stewart, John, of Belladrum	1819
Stewart, John, of Dalguise	1823
Stewart, John, of Findynate, M.D., R.N.	1839
Stewart, John, of Binny	1809
Stewart, John, of Crossmount	1801
Stewart, John, of Achadashenaig	1824
Stewart, John Lorn, of Glenbuckie	1824
Stewart, John, Gabroch Hill, Glasgow	1845
Stewart, John Henry Fraser, yr. of Belladrum, 24th Regiment	1843
Stewart, Major Ludovic, Pittyvaich	1806
Stewart, Mark S., of Southwick	1837
Stewart, Robert, of Ardvorlich	1823
Stewart, Robert, of Carfin, W.S.	1833
Stewart, Robert, of Parson's Green	1844

	Admitted
Stewart, Robert Hawthorn Johnstone, yr. of Physgill	1846
Stewart, Samuel M'Dowall, Buchanan Street, Glasgow	1845
Stewart, Stair H., of Physgill and Glasserton	1828
Stewart, William, Sheriff-Clerk, Kincardineshire	1825
Stewart, William, Ballaterach, Ballater	1829
Stewart, William, Blackhouse, Largs	1844
Stewart, William, of Shambelly	1845
Stirling, General A. Graham, of Duchray and Auchyle	1801
Stirling, Alexander Gartshore, of Craigbarnet	1818
Stirling, John, of Kippendavie	1833
Stirling, J. D. Morris, of Blackgrange	1841
Stirling, Thomas Graham, of Strowan	1839
Stirling, William, of Content	1823
Stirling, William, yr. of Keir	1841
Stirling, William Moray, of Abercairny	1825
Stocks, David, of Invernyte	1836
Stocks, James, Land-Surveyor, Kinross	1837
Stodart, George Tweedie, of Oliver, W.S.	1839
Stodart, John, Cartland Mains	1829
Stoddart, Alexander, of Ballendreck	1829
Stott, Gibson, of Balloch Castle	1832
Strang, William, Lopness, Orkney	1819
Straton, George Thomas, of Kirkside	1842
Stronach, John, Fife Keith	1823
Stronach, William, Ardmellie, Royal Engineers	1840
Stuart, Alexander, of Laithers	1835
Stuart, Charles, of Ballahulish	1827
Stuart, Captain John, of the Princess of Wales Excise Yacht	1809
Sturrock, John, Banker, Dundee	1843
Sutherland, Captain George Mackay, of Aberarder	1832
Sutherland, James, Distiller, Tacksman of Aldourie	1839
Sutherland, William, Ulbster, Caithness	1839
Swinburne, Colonel T. R., of Marcus	1843
Swinton, Archibald, Advocate, Professor of Civil Law, Edinburgh	1841
Swinton, George, H.E.I.C.S.	1834
Swinton, John, Inverleith Place	1810
Syme, James, Professor of Clinical Surgery, University of Edinburgh	1838
Symers, Colin, of Kingskettle	1843
Symers, John, Banker, Dundee	1843

T

†Tweeddale, Most Noble George, Marquis of, K.T.	1809
Traquair, The Right Honourable Charles, Earl of	1811

	Admitted
TALBOT, The Right Honourable John, Earl of, K.G., Honorary Member	1827
TORPHICHEN, The Right Honourable James, Lord	1821
THREIPLAND, Sir Patrick Murray, of Fingask, Bart.	1824
Tait, Captain Alexander, of Milrig	1845
Tait, George, Advocate	1808
Tait, James, Banker, Kelso	1846
Tait, John, Advocate, Sheriff of Kinross and Clackmannan	1834
Taitt, George, of Langrig	1825
Tawse, Andrew, W.S.	1836
Tawse, John, Advocate, Secretary to the Society for Propagating Christian Knowledge	1825
Tayler, Major Alexander Francis, Rothiemay House	1814
Taylor, Robert, of Kirktonhill	1837
Taylor, William, North Queensferry	1828
Tennant, John, of St. Rollox	1833
Tennant, Charles J, St. Rollox, Glasgow	1838
Tennant, Hugh, of We'l Park, Glasgow	1838
Thom, Robert, of Ascog	1818
Thom, Robert, yr. of Ascog	1844
Thoms, Peter, Merchant, Dundee	1843
Thoms, Alexander, of Rumgay	1842
Thomson, Alexander, of Banchory	1821
Thomson, Alexander, Banker, Greenock	1825
Thomson, Alexander, of Whiteriggs	1838
Thomson, Arthur, Agent for Bank of Scotland at Aberdeen	1841
Thomson, George, of Burnhouse, Advocate	1836
Thomson, James, Kimmerghame Mains	1828
Thomson, John, Bookseller, Edinburgh	1811
Thomson, John, Craigie	1836
Thomson, John, Charlotte Square, Edinburgh	1833
Thomson, John, Inverness	1839
Thomson, Peter, Hangingside	1838
Thomson, Robert, Advocate, Sheriff of Caithness	1835
Thomson, Thomas, Advocate, Principal Clerk of Session	1807
Thomson, William, of Woodhouse	1828
Thomson, William, of Pleasance	1843
Thomson, William, Charlotte Square, Edinburgh	1844
Thomson, William Thomas, Manager Standard Assurance Company, Edinburgh	1841
Thorburn, David, of Cargenholm	1845
Thorburn, Kenneth M'K., W.S.	1842
Threshie, David Scott, W.S.	1824
Threshie, Robert, of Barnbarroch	1835
Timins, William, of Hillfield, Stanmore, Middlesex	1844
Tod, Hugh, W.S.	1817

	Admitted
Tod, John, of Finnich Mellise, Dumbarton	1838
Tod, John, of Kirkhill, W.S.	1838
Tod, Peter, of Meikleholmside	1829
Tod, Peter, Burican, Arran	1844
Torrance, George Macknikin, of Threave	1827
Torrance, Thomas, Meadowhead	1831
Torrance, William, Gilmerton	1831
Torrie, Thomas Jameson, Advocate	1837
Traill, George, of Ratter, M.P.	1822
Traill, George William, of Viera, Hanover Square, London	1840
Traill, Thomas Stewart, M.D., Professor of Medical Jurisprudence in the University of Edinburgh	1834
Traill, William, of Woodwick, Orkney	1821
Traquair, Ramsay H., Colinton	1846
Trotter, Archibald, of Dryden,	1845
Trotter, Charles, Regent Terrace	1841
Trotter, Captain Robert Knox, of Ballindean	1829
Trotter, John P., Advocate, Sheriff-Substitute, Dumfries	1831
Trotter, John, of Castlelaw and Bush	1845
Trotter, Richard, of Mortonhall	1836
Trotter, Thomas, W.S.	1828
Turnbull, Archibald, of Bellwood	1826
Turnbull, George, of Abbey St. Bathans, W.S.	1833
Turnbull, John, yr. of Abbey St. Bathans, W.S.	1844
Turnbull, John, Spittal	1842
Turnbull, Joseph, Bonhill Place, Dumbarton	1838
Turnbull, Phipps, Crooks	1841
Turner, Angus, Town-Clerk, Glasgow	1844
Turner, Geo. of Menie, Lieut.-Col. Royal Horse Artillery	1828
Turner, William, Surgeon, Greenock	1831
Tytler, James, of Woodhouselee	1840
Tytler, William Fraser, of Balmain and Burdsyards, Sheriff of Inverness-shire	1802

U

Unwin, William Heathcot, Allean Cottage, Pitlochry	1839
Ure, James, Maryborough, Ross-shire	1839
Urquhart, Beauchamp Colclough, of Byth and Meldrum	1834

V

Veitch, James, of Elliock	1822
Veitch, John, of Woodside	1833
Vere, Daniel, Advocate	1807
Vere, W. E. Hope, of Craigiehall and Blackwood, Grenadier Guards	1846

Admitted

W

WELLINGTON, Field-Marshal His Grace Arthur, Duke of, K.G., &c., Honorary Member 1815
†WEMYSS and MARCH, The Right Hon. Francis, Earl of 1793
†WILLOUGHBY DE ERESBY and GWYDIR, The Right Hon. P. Drummond Burrell, Lord 1808
WARD, Right Honourable William, Lord 1813
WALPOLE, The Honourable Henry, Wolterton Park . 1845
WARRENDER, The Right Hon. Sir George, of Lochend, Bart. 1804
Waddell, George, of Ballochnie, W.S. 1824
Waddell, William, of Easter Moffat, W.S. 1818
Waldie, John, Kelso 1824
Waldie, John, of Henderside 1826
Walker, Bethune James, of Fallfield 1835
Walker, James, Suttie, Fintray 1835
Walker, James, of Dalry, Principal Clerk of Session 1835
Walker, John, of Crawfordton 1834
Walker, Robert, Ferrygate 1834
Walker, Robert, Lathamhill, Barony 1844
Walker, Robert, Mains of Portlethen, Kincardineshire 1847
Walker, Dr. Thomas, of Polmont Bank 1843
Walker, William S., of Bowland 1835
Wallace, Captain Patrick, H.E.I.C.S., St. Andrews 1841
Wallace, Patrick, Coach-Builder to Her Majesty for Scotland 1842
Wallace, Robert, late of Kelly 1825
Wallace, William, of Auchinvole 1844
Ware, Dr. Samuel Hibbert, of Hall Barns, Altringham, Cheshire 1840
Warner, Patrick, of Ardeer 1811
Wason, Rigby, of Mayfield 1836
Waters, James, Collector of the Customs, Wick 1839
Waterston, Charles, Manager of the Caledonian Banking Company, Inverness 1839
Watson, Alexander, Banker, Granton 1842
Watson, Henry George, Accountant, Edinburgh 1811
Watson, Hugh, Keillor Farm 1828
Watson, John, Manager of the Edin. Gas Light Company 1825
Watson, Robert, Town-Clerk, Forres 1841
Watson, William, of Burnhead 1841
Watson, William Dickson, late of Press 1810
Watt, James, of Crawfordsdyke 1825
Watt, Robert, Factor on the estates of Closeburn and Mansfield 1835
Wauchope, Andrew, of Niddrie Marischall 1840
Wauchope, John, of Edmonstone 1842
Wauchope, George, Moray Place 1824

	Admitted
Webster, Alexander, Advocate, Aberdeen	1840
Webster, John, Factor for W. F. Campbell, Esq. of Islay, on the Estate of Woodhall	1839
Webster, William, Factor to W. F. Campbell, Esq of Islay	1838
Wedderburn, David, of Pearsie	1831
Wedderburn, Frederick S., of Birkhill	1844
Weir, Thomas, of Bogangreen	1835
Welsh, David, of Colin, W.S.	1830
Welsh, James, Earlshaugh	1826
Welsh, Robert, of Mossfennan	1840
Wemyss, David Sinclair, of Southdun	1846
Wemyss, James Erskine, of Wemyss, Captain R.N., M.P.	1823
Wemyss, James, of Wemyss-hall	1841
Wetherell, William, Land Agent, Durham	1836
Whigham, Robert, of Lochpatrick, Advocate, Sheriff of Perthshire	1827
White, Alexander, of Fens, Merchant, Leith	1829
White, Henry W., of Monar	1842
White, James, Merchant, Leith	1842
White, John, of Drumelzier	1842
White, Peter, Accountant in Glasgow	1838
White, William, late of Gibraltar, Merchant, Glasgow	1838
White, Robert, W.S.	1842
Whitehead, Joseph, yr. of Kilnside	1845
Whitton, Andrew, of Couston	1843
Whyte, Thomas, of Glenesslin	1829
Wightman, James Seaton, of Courance	1827
Wilkie, Daniel, Superintendent for Scotland of the Agriculturist Cattle Insurance Company	1847
Wilkie, Duncan, Kirriemuir	1843
Wilkie, Major James, of Newbarns	1836
Wilkie, John, of Foulden	1830
Wilkie, William, of Bonnington	1824
Williamson, Charles Alexander, of Balgray	1833
Williamson, Donald, Banker, Tain	1847
Williamson, Captain James Ker, of Cardrona	1842
Williamson, John W., of West Green, Agent for the British Linen Company, Kinross	1829
Wilson, Alexander, Kilnhillock, Banffshire	1842
Wilson, Francis Johnstone, of Stroquhan	1843
Wilson, George, M.D., Lecturer on Chemistry	1845
Wilson, James, Agent at Inverness for the Commercial Bank of Scotland	1840
Wilson, James, Corn Merchant, Dundee	1843
Wilson, James, Virginia Street, Glasgow	1844
Wilson, John, of Auchineden	1835

	Admitted
Wilson, John, of Thornly	1830
Wilson, John, Professor of Moral Philosophy in the University of Edinburgh	1835
Wilson, John, late Factor to the Duchesse de Coigny	1835
Wilson, John, of Arden	1843
Wilson, John, younger of Arden	1843
Wilson, John, of Cumledge	1841
Wilson, John, Tochieneal, Factor for the Earl of Seafield	1842
Wilson, Peter, W.S., Wick	1841
Wilson, Robert Sym, Cashier of the Royal Bank of Scotland	1841
Wilson, William, late Factor for the Earl of Glasgow	1804
Wilson, William, of Campbellfield	1843
Wilson, William Rae, of Kelvinbank	1807
Wilsone, George Ross, of Benmore	1826
Wingate, Andrew, Merchant, Glasgow	1838
Wood, John, Factor on the Estate of Balcarras	1835
Wood, J. Stewart	1844
Wood, William, Merchant, Leith	1828
Wood, William E. Collins, of Keithock	1841
Woodburn, William, Commissioner on the estates of Nithsdale and Terregles	1829
Wooly, Richard, late of Wester Dalry	1821
Wright, Major-General, Royal Engineers	1833
Wright, James, of Lawton	1817
Wright, James, St. Vincent Street, Glasgow	1839
Wright, Thomas Guthrie, Auditor, Court of Session	1821
Wyld, James, of Gilston	1802
Wylie, David, Circuit-Clerk of Justiciary, Edinburgh	1825
Wylie, James, Factor for the Marquis of Breadalbane	1833

Y

Yeats, William, yr. of Aquharney, Advocate, Aberdeen	1838
Yorstoun, William Grierson, of Garroch	1828
Young, Harry, of Cleish	1812
Young, James, Land-Surveyor, Pitfour	1841
Young, Samuel D., late of Gullyhill	1826
Young, William, W.S.	1821
Yuille, Andrew Buchanan, of Darleith	1838
Yule, John, Factor to Sir James Graham of Netherby, Bart., M.P.	1828
Yule, Captain Patrick, Royal Engineers	1827

Z

ZETLAND, The Right Hon. Thomas, Earl of	1810